Instruction Report ITL-96-2
June 1996

US Army Corps of Engineers
Waterways Experiment Station

Computer-Aided Structural Engineering (CASE) Project

Computer-Aided Structural Modeling (CASM) Version 6.00

Report 3
Scheme A

by David Wickersheimer, Carl Roth, Gene McDermott
Wickersheimer Engineers, Inc.

Prepared for Headquarters, U.S. Army Corps of Engineers

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821 South Neil Street
Champaign, IL 61820

Report 3 of a series

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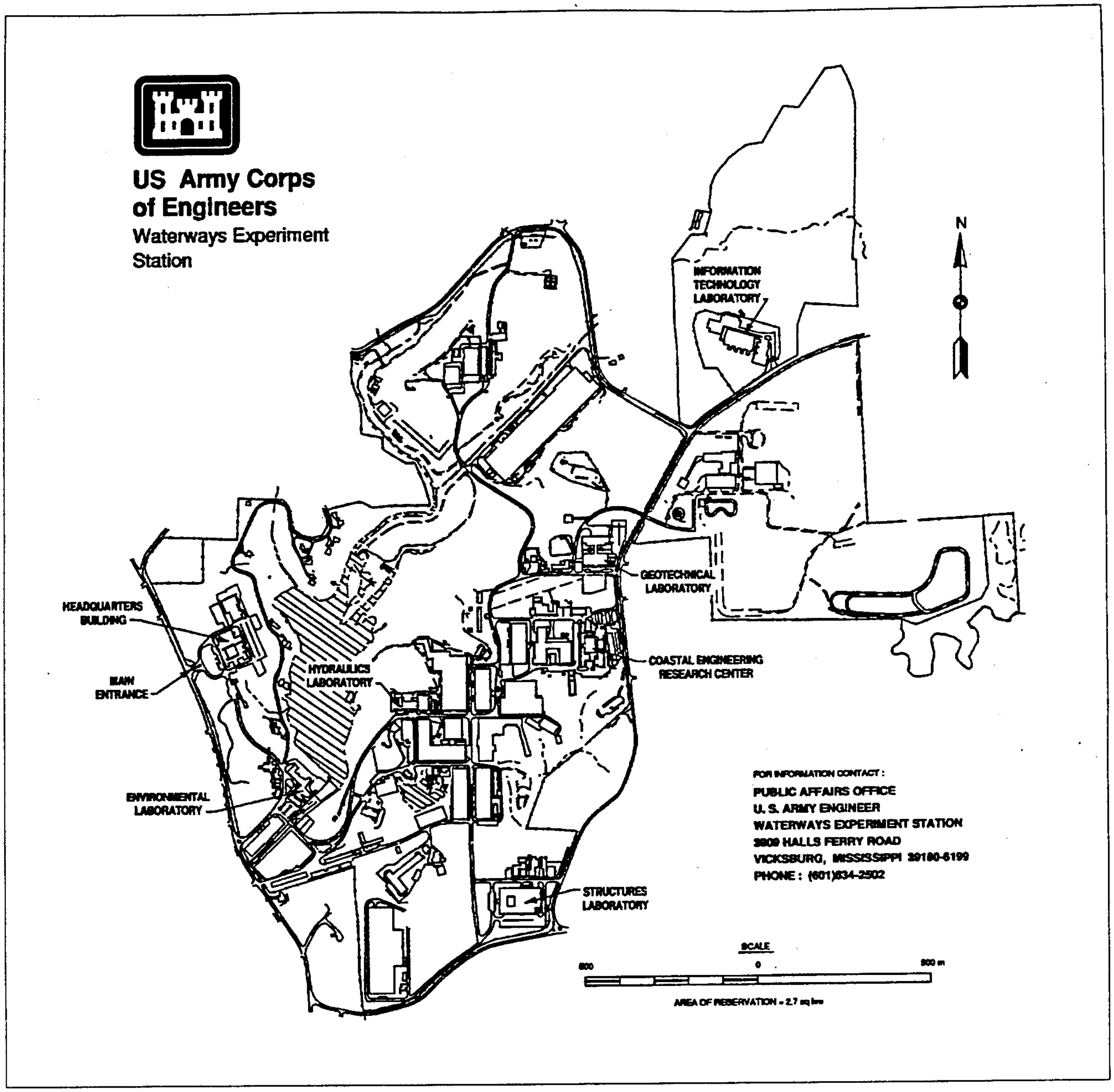
Washington, DC 20314-1000

Monitored by U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, MS 39180-6199

Under Work Unit AT40-CA-001



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PREFACE

This report describes the computer program CASM, which is designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional interactive graphics, to determine the structural framing scheme for a rigid frame, all steel, noncomposite, with lateral load resistance. Funds for the development of this program and publication of this user's guide were provided to the Information Technology Laboratory (ITL), U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, by the Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers (HQUSACE), under the Research, Development, Test, and Evaluation (RDT&E) program. The work was accomplished under Work Unit No. AT40-CA-001 entitled "CASE (Computer Aided Structural Engineering) Building Systems." The work was performed by members of Wickersheimer Engineers, Inc., of Champaign, IL, under Contract No. DACA39-86-C-0024.

Specifications for the program were provided by members of the Building Systems Task Group of the CASE Project. The following were members of the task group during program development:

- Mr. Dan Reynolds, U.S. Army Engineer (USAE) District, Sacramento (Chairman)
- Ms. Anjana Chudgar, USAE Division, Ohio River
- Mr. Pete Rossbach, USAE District, Baltimore
- Mr. Dave Smith, USAE District, Omaha
- Mr. Mark Burkholder, USAE District, Tulsa
- Mr. Jerry Maurseth, USAE District, Portland
- Mr. Chris Merrill, WES
- Mr. Michael Pace, WES

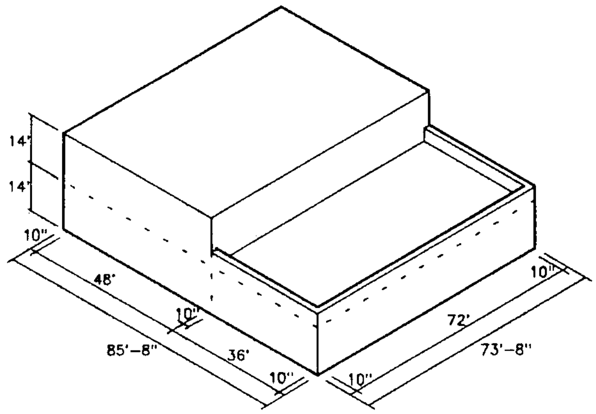
The computer program and report were written by Messrs. David Wickersheimer, Gene McDermott, and Carl Roth of Wickersheimer Engineers, Inc.

The work was monitored at WES by Mr. Michael E. Pace and Mr. Chris Merrill, Computer-Aided Engineering Division (CAED), under the general supervision of Mr. H. Wayne Jones, Chief, Scientific and Engineering Applications Center; Dr. Reed Mosher, Chief, CAED; Mr. Timothy Ables, Assistant Director, ITL; and Dr. N. Radhakrishnan, Director, ITL. Mr. Donald Dressler was the original HQUSACE point of contact, and Mr. Charlie Gutberlet is the present technical monitor.

Dr. Robert W. Whalin is Director of WES. COL Bruce K. Howard, EN, is Commander.

Table of Contents

Project Description



This 1 and 2 story project is to provide approximately 9,500 gross square feet of office space for one of two possible sites:

(a) Charleston, South Carolina

(b) Radford AAP, Virginia

Soil conditions are unknown at both sites.

The following project criteria has been established:

1. The 36' x 72' space on the first level shall be column free for open office planning.

2. The 48' x 72' first and second floor areas shall provide 24' square bays.

3. The first floor shall be a slab on grade with the tops of perimeter continuous wall footings set at 2'-6" below grade. Column footings will be isolated spread footings.

4. The second floor occupancy live loads located on the plan are:

Offices:	50 psf
File Storage:	150 psf
Corridor, Stair & Lobby:	100 psf

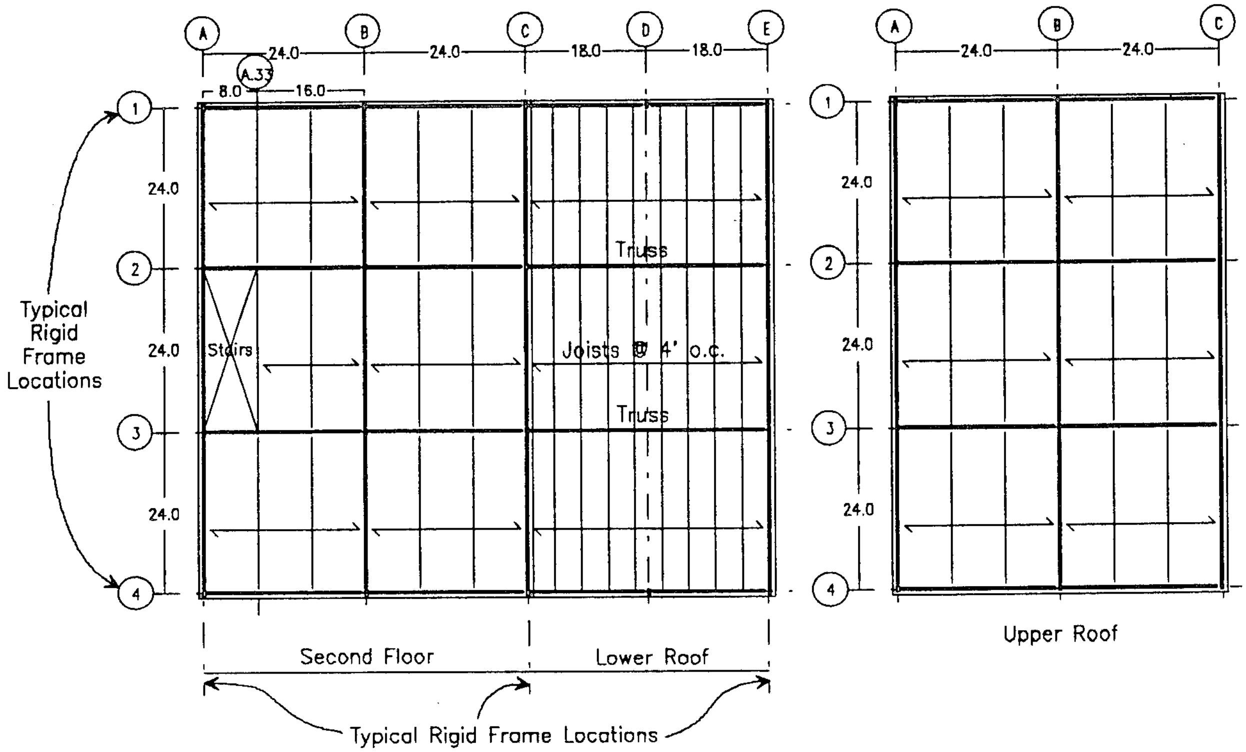
5. Structural framing schemes to be designed and compared shall be as follows:

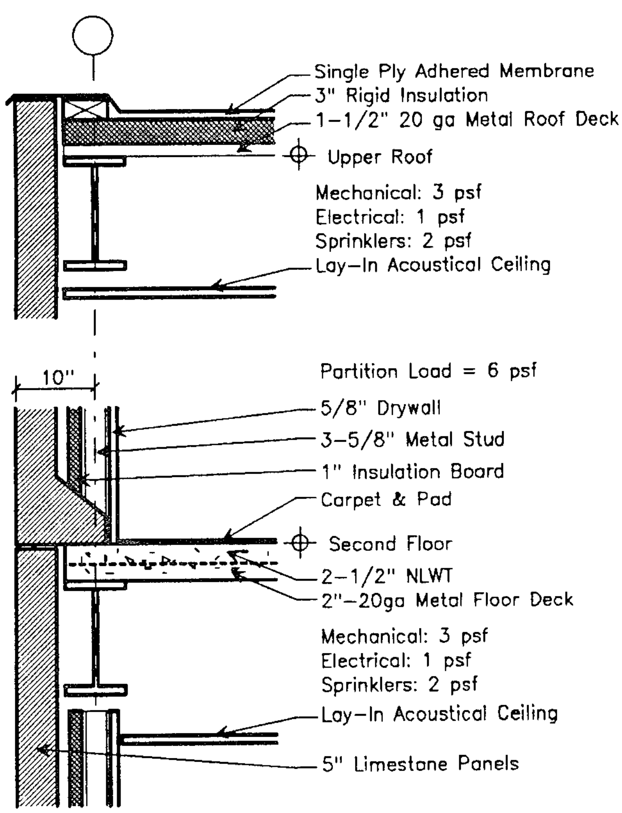
Scheme A: All steel, non-composite,
lateral load resistance = rigid frames.

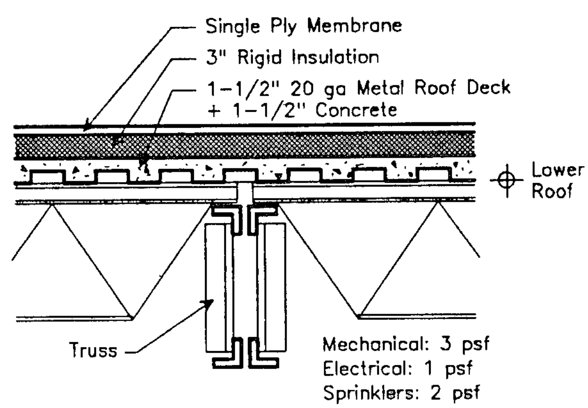
Scheme B: All steel, composite,
lateral load resistance = X braced frames.

Scheme C: Monolithic concrete for two story portion, steel for lower roof portion,
lateral load resistance = shear walls.

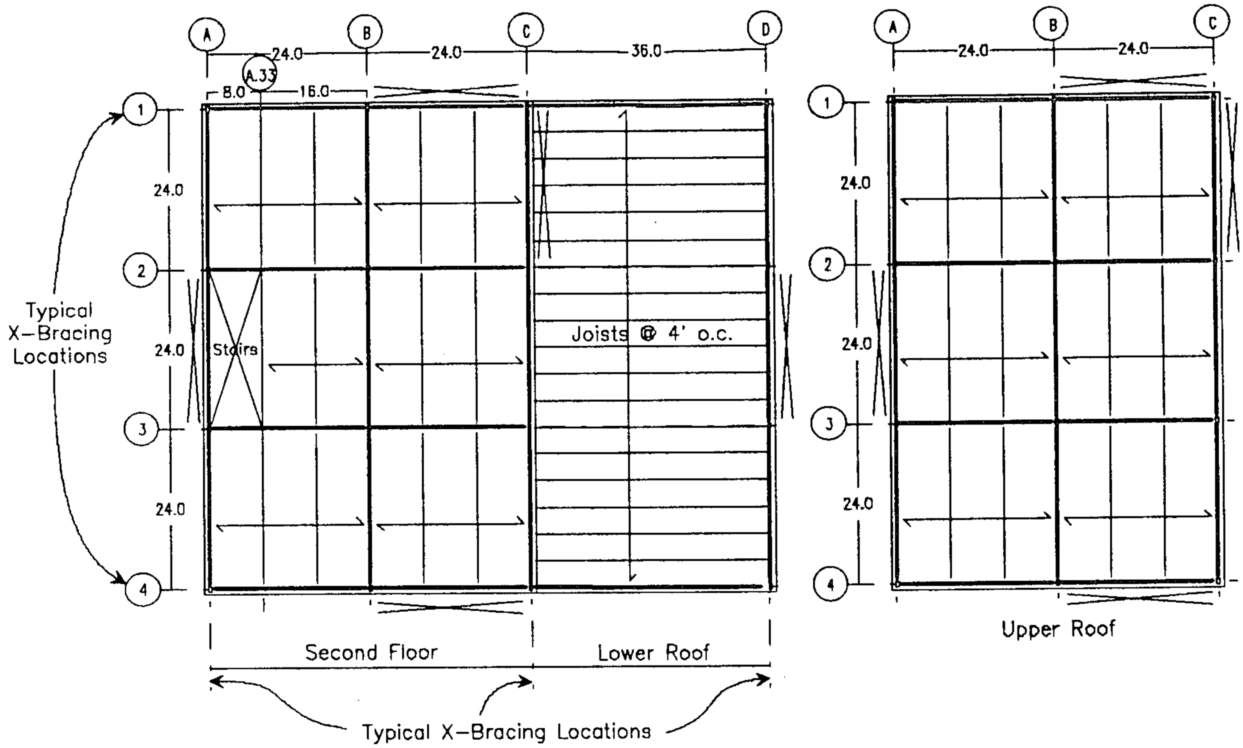
Scheme A

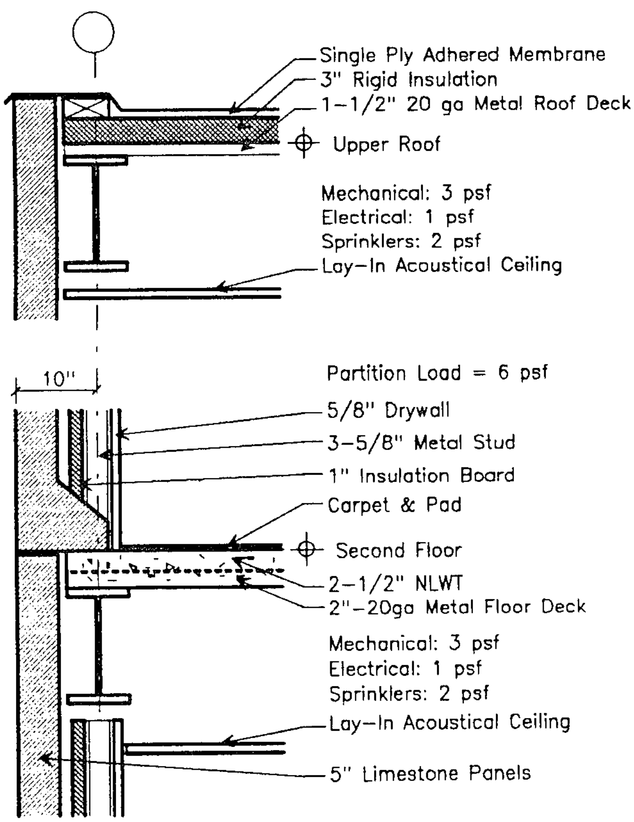

A
B
C
D
E
24.0
24.0
18.0
18.0
A.33
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Typical Rigid Frame Locations
Truss
Stairs
Joists @ 4' o.c.
Truss
Second Floor
Lower Roof
Typical Rigid Frame Locations
Upper Roof

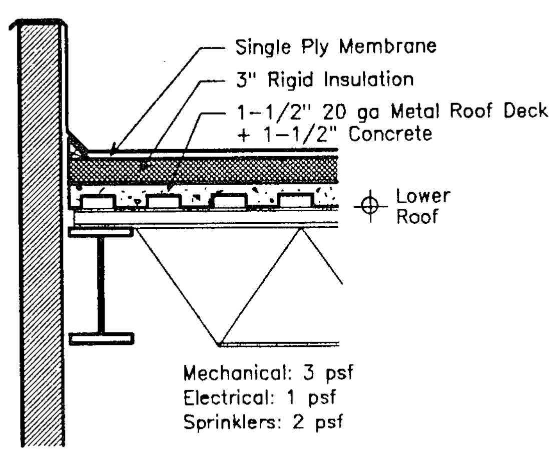

Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2-1/2" NLWT
2"-20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
+ 1-1/2" Concrete
Lower Roof
Truss
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

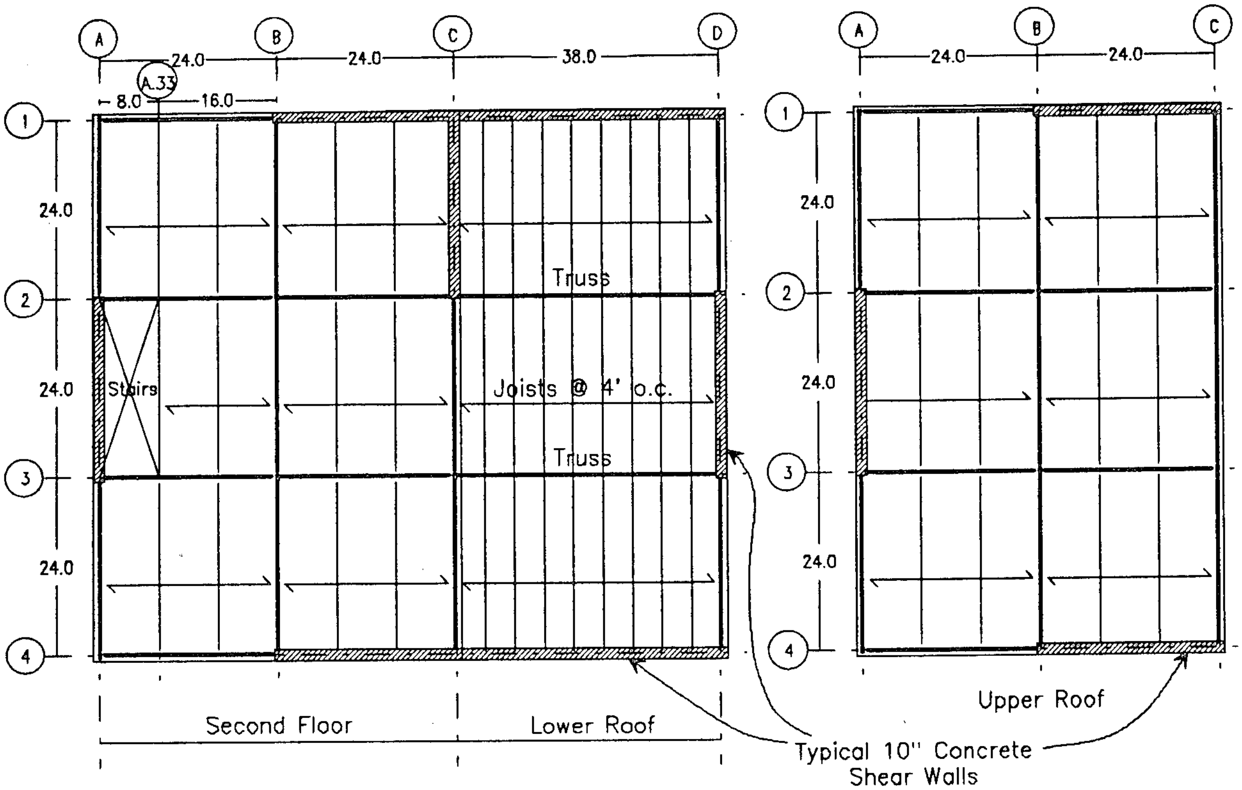
Scheme B

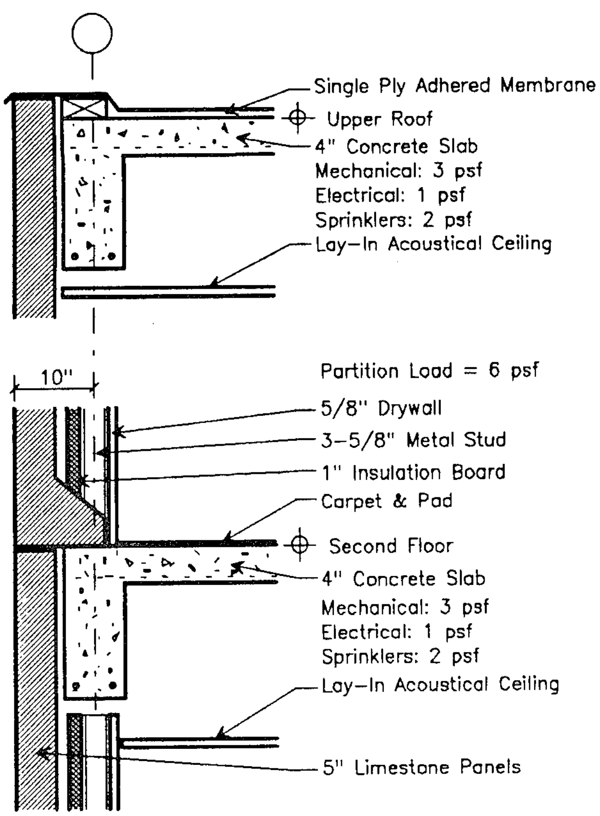

A
B
C
D
24.0
24.0
36.0
A.33
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Typical X–Bracing Locations
Stairs
Joists @ 4' o.c.
Second Floor
Lower Roof
Typical X–Bracing Locations
Upper Roof

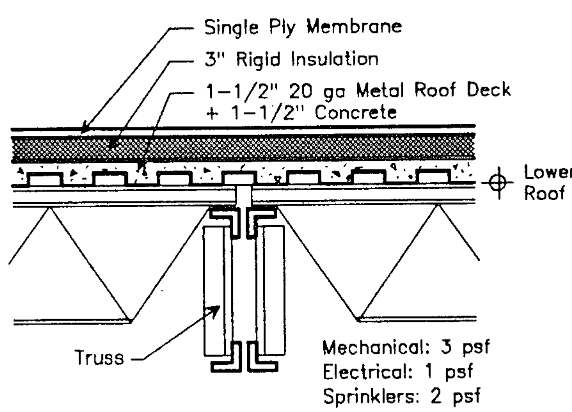

Single Ply Adhered Membrane
3" Rigid Insulation
1–1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay–In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3–5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2–1/2" NLWT
2"–20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay–In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1–1/2" 20 ga Metal Roof Deck
+ 1–1/2" Concrete
Lower Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

Scheme C


A
B
C
D
A.33
24.0
38.0
8.0
16.0
1
2
3
4
Stairs
Truss
Joists @ 4' o.c.
Truss
Second Floor
Lower Roof
Upper Roof
Typical 10" Concrete Shear Walls


Single Ply Adhered Membrane
Upper Roof
4" Concrete Slab
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
4" Concrete Slab
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck + 1-1/2" Concrete
Lower Roof
Truss
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

6. The typical exterior envelope consists of 5" limestone panels, 1" rigid insulation, 3-5/8" metal studs, and 5/8" drywall.

7. Window and door openings are uniformly distributed to all elevations.

8. Load Assumptions:

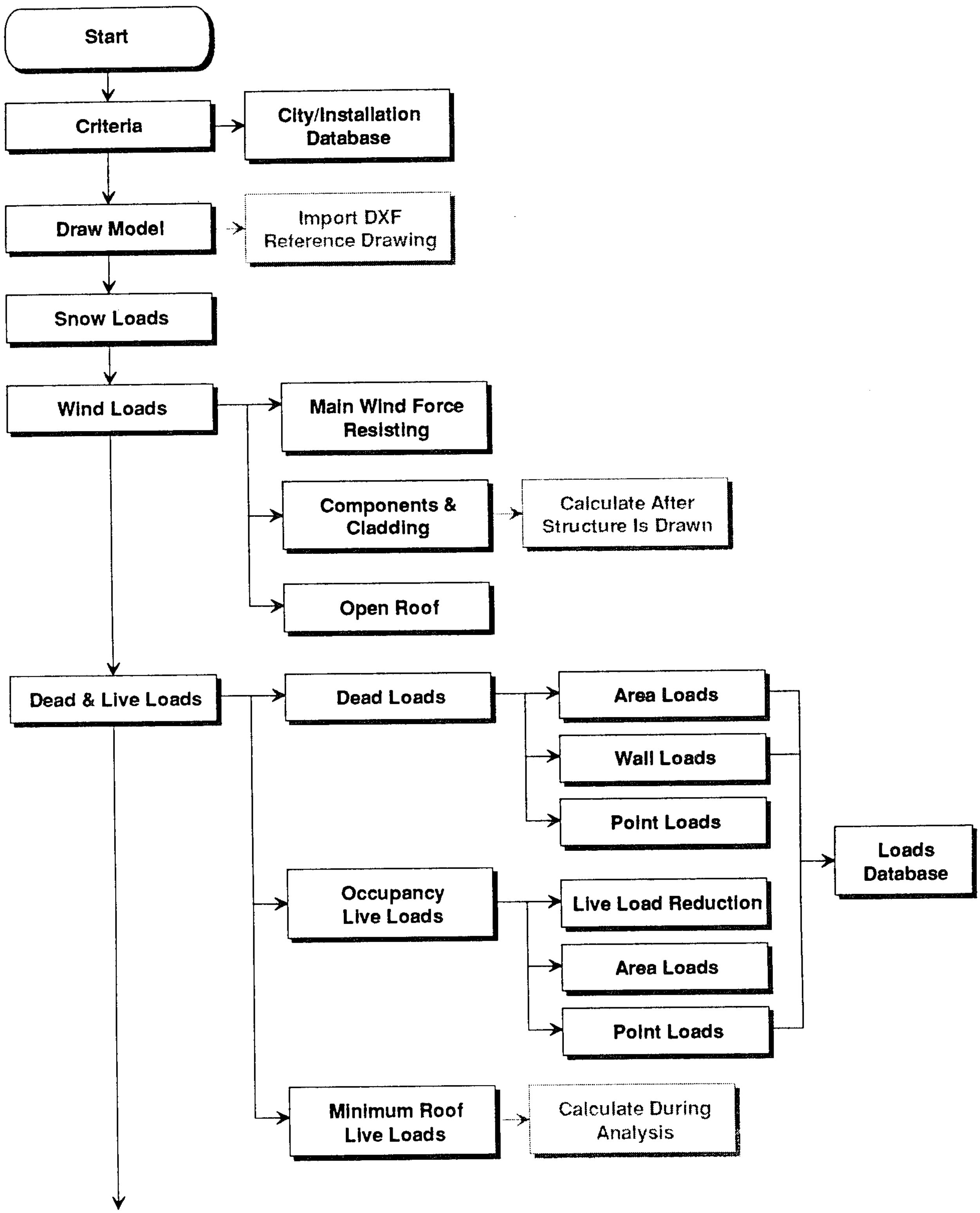
	Importance Category	Exposure Category
Snow:	I	C
Wind:	I	C
Seismic:	IV	

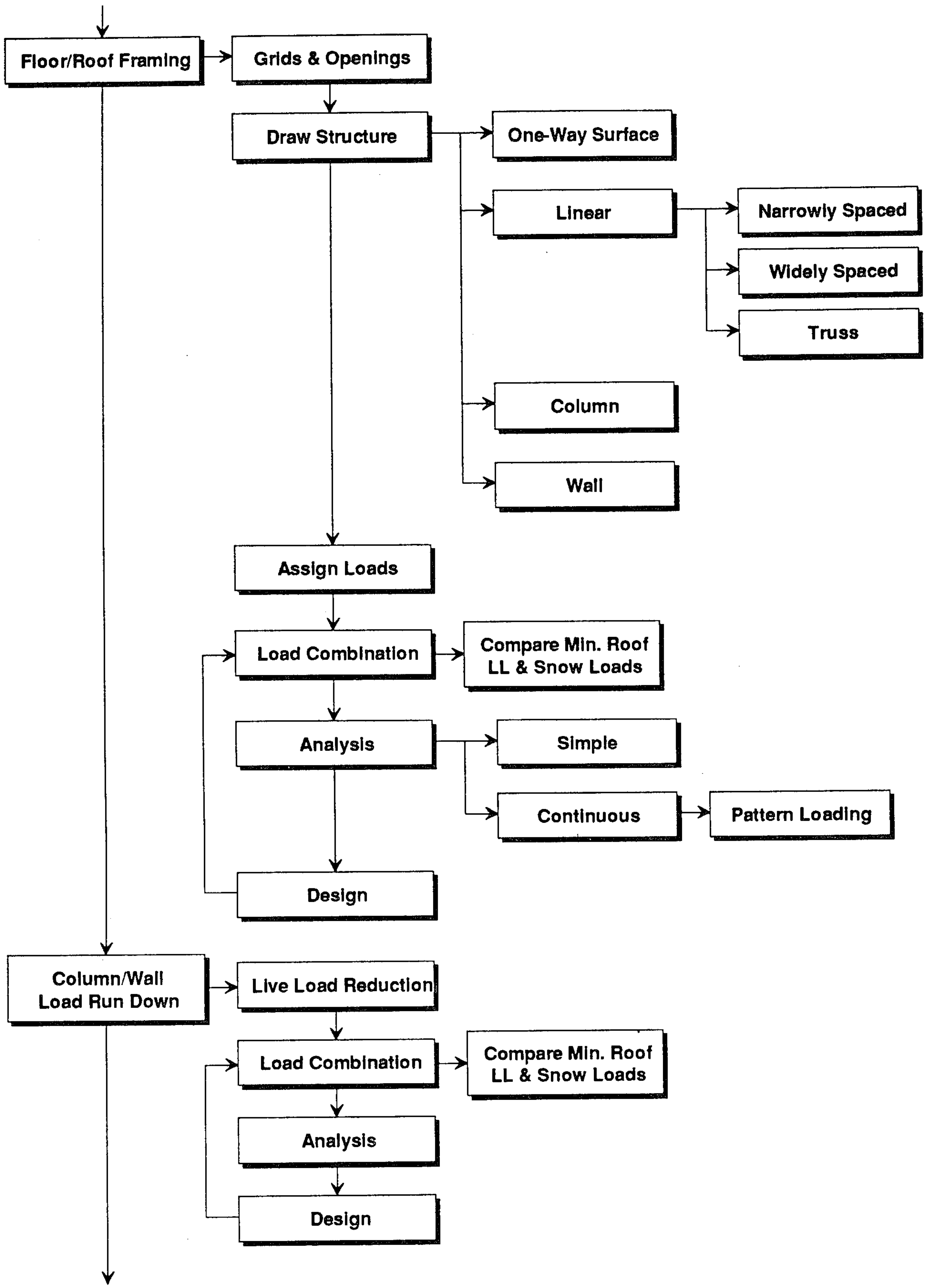
9. Material Assumptions:

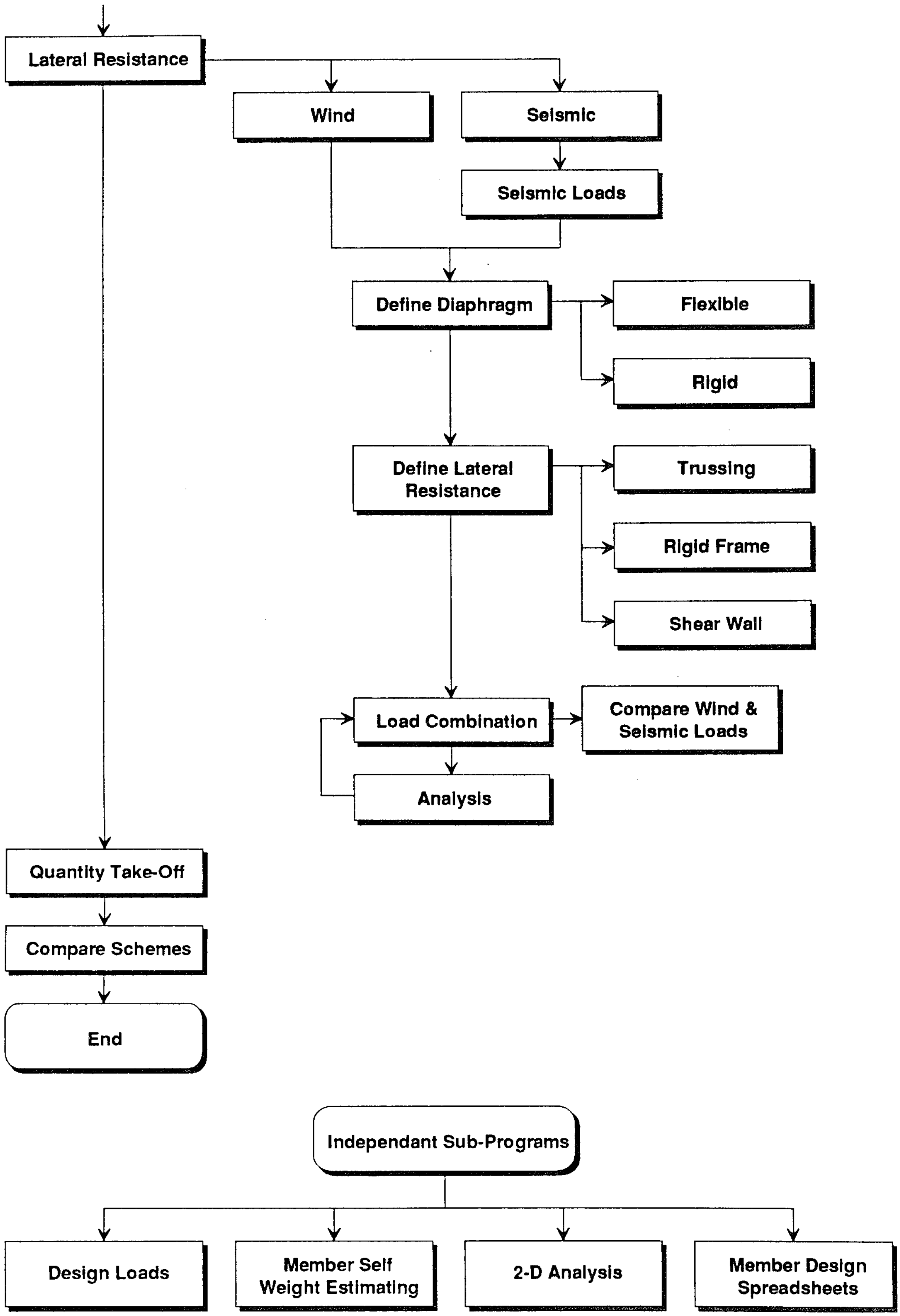
Concrete:	4,000 psi, NLWT
	Steel Reinforcing: Grade 60
Steel:	A36

10. Fire resistance rating shall be achieved by a wet sprinkler system.

Computer Aided Structural Modeling




Floor/Roof Framing
Grids & Openings
Draw Structure
One-Way Surface
Linear
Narrowly Spaced
Widely Spaced
Truss
Column
Wall
Assign Loads
Load Combination
Compare Min. Roof LL & Snow Loads
Analysis
Simple
Continuous
Pattern Loading
Design
Column/Wall Load Run Down
Live Load Reduction
Load Combination
Compare Min. Roof LL & Snow Loads
Analysis
Design


Lateral Resistance
Wind
Seismic
Seismic Loads
Define Diaphragm
Flexible
Rigid
Define Lateral Resistance
Trussing
Rigid Frame
Shear Wall
Load Combination
Compare Wind & Seismic Loads
Analysis
Quantity Take-Off
Compare Schemes
End
Independant Sub-Programs
Design Loads
Member Self Weight Estimating
2-D Analysis
Member Design Spreadsheets

Criteria

Start

Use Criteria Menu

Project

Project Data

Project Name:	Office Building - Scheme A
City/Installation:	Radford AAP
Country:	USA
State:	VA
County:	Pulaski
Design Load:	TM 5-809-1 1992
Building Code:	BOCA
Seismic Code:	TM 5-809-10 1992
Elevation Above Sea Level:	3300 ft
No. Of Stories:	2
Floor Area:	9504 sq ft
Occupancy:	Use Group B
Type Const:	3A
Seismic Lateral Load Resistance	
N-S System:	Blank
E-W System:	Blank

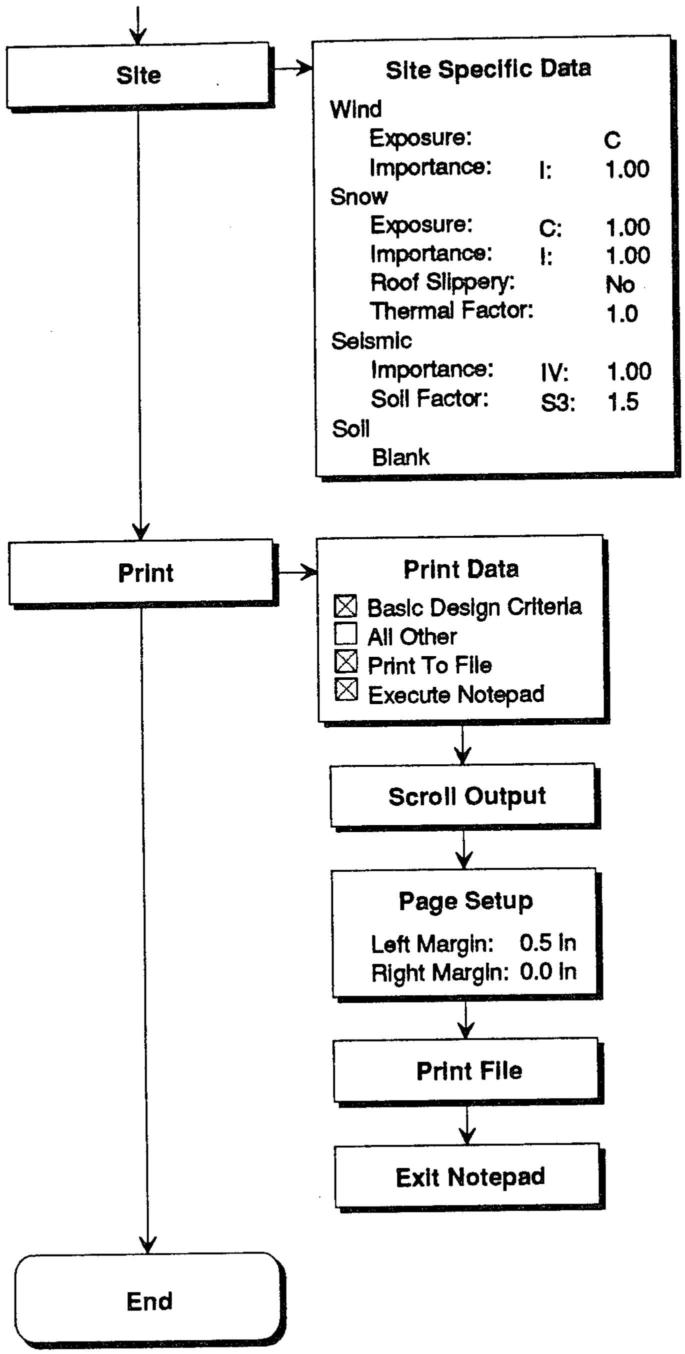
City/Installation

Select Radford AAP From List

Regional

Review Regional Data

Wind		
Basic Wind Speed:	70.0	mph
Coastal:	No	
Maximum Wind Speed:	58.0	mph
Wind Direction:	SE	
Snow		
Ground Snow Load:	25.0	psf
Maximum Snow Depth:	15.0	in
Snow Density:	17.3	pcf
Rain		
Average Annual Rainfall:	44.0	in
Maximum Rainfall:	4.0	in
Temperature		
Maximum temperature:	92	°F
Minimum Temperature:	-24	°F
Seismic Zone: 2A:	0.150	
Frost Depth:	22	in


Site
Site Specific Data
Wind
Exposure: C
Importance: I: 1.00
Snow
Exposure: C: 1.00
Importance: I: 1.00
Roof Slippery: No
Thermal Factor: 1.0
Seismic
Importance: IV: 1.00
Soil Factor: S3: 1.5
Soil
Blank
Print
Print Data
☒ Basic Design Criteria
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

```
Basic Design Criteria

Project Data
    Project Name                : Office Building - Scheme A
    City/Installation           : Radford AAP
    Country                     : USA
    State                       : VA
    County                      : Pulaski
    Design Load                 : TM 5-809-1 1992
    Building Code               : BOCA
    Seismic Code                : TM 5-809-10 1992
    Elevation Above Sea Level   :   3300 ft
    No. of Stories              :      2
    Floor Area                  :   9504 sqft
    Occupancy                   : Use Group B
    Type of Construction        : 3A
    Seismic Lateral Load Resistance
      N-S System                :
      N-S Rw                    :      0
      E-W System                :
      E-W Rw                    :      0

Regional Data
  Wind
    Basic Wind Speed From Map   :   70.0 mph
    Calculated Wind Speed       :    0.0 mph
    Coastal                     :     No
    Maximum Wind Speed          :   58.0 mph
    Wind Direction              :     SE
  Snow
    Ground Snow Load            :   25.0 psf
    Maximum Snow Depth          :   15.0 in
    Snow Density                :   17.3 pcf
  Rain
    Average Annual Rainfall     :   44.0 in
    Maximum Rainfall            :    4.0 in
  Temperature
    Maximum Temperature         :   92.0 °F
    Minimum Temperature         :  -24.0 °F
  Seismic Zone   : 2A           :  0.150
  Frost Depth                   :     22 in

Site Specific Data
  Wind
    Exposure                    :      C
    Importance   : I            :   1.00
  Snow
    Exposure     : C            :   1.00
    Importance   : I            :   1.00
    Roof Slippery               :     No
    Thermal Factor              :    1.0
  Seismic
    Importance    : IV          :   1.00
    Soil Factor : S3            :    1.5

Notes
  Importance Factor for Snow and Wind:
    I   All buildings and structures except those listed below.
    II  Buildings and structures where primary occupancy is one in which
        more than 300 people congregate in one area.
    III Buildings and structures designated as essential facilities,
        including, but not limited to:
          Hospital and other medical facilities having surgery or emergency
          treatment areas.
          Fire or rescue and police stations.
          Primary communication facilities and disaster operation centers.
          Power stations and other utilities required in an emergency.
```

Structures having critical national defense capabilities.
IV Buildings and structures that represent a low hazard to human life in the event of failure, such as agricultural buildings, certain temporary facilities, and minor storage facilities.

Wind Exposure Category:
Exposure C:
Open terrain with scattered obstructions having heights generally less than 30.0 ft.

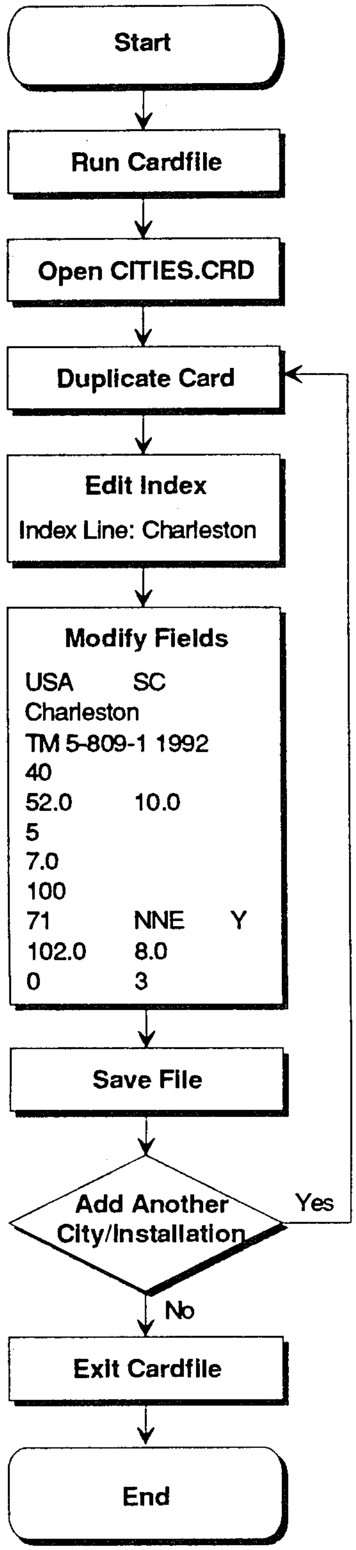
Snow Exposure Category:
Exposure C:
Locations in which snow removal by wind cannot be relied on to reduce roof loads because of terrain, higher structures, or several trees nearby.
* The conditions discussed should be representative of those that are likely to exist during the life of the structure. Roofs that contain several large pieces of mechanical equipment or other obstructions do not qualify for siting category A.

Snow Thermal Factor:
Heated Structure.
* These conditions should be representative of those that are likely to exist during the life of the structure.

Importance Factor for Seismic:
I. Essential Facilities
Hospitals and other medical facilities having surgery and emergency treatment areas.
Fire and police stations.
Tanks or other structures containing, housing or supporting water or other fire-suppression materials or equipment required for the protection of essential or hazardous facilities, or special occupancy structures.
Emergency vehicle shelters and garages.
Structures and equipment in emergency preparedness centers.
Stand-by power generating equipment for essential facilities.
Structures and equipment in communication centers and other facilities required for emergency response.
II. Hazardous Facilities
Structures housing, supporting or containing sufficient quantities of toxic or explosive substances to be dangerous to the safety of the general public if released.
III. Special Occupancy Structure
Covered structures whose primary occupancy is public assembly - capacity more than 300 persons.
Buildings for schools (through secondary) or day-care centers - capacity more than 250 students.
Buildings for colleges or adult education schools - capacity more than 500 students.
Medical facilities with 50 or more resident incapacitated patients, but not included above.
Jails and detention facilities.
All structures with occupancy more than 5000 persons.
Structures and equipment in power generating stations and other public utility facilities not included above, and required for continued operation.
IV. Standard Occupancy Structure
All Structures having occupancies or functions not listed above.

Seismic Soil Factor:
S3: A soil profile 70.0 ft or more in depth and containing more than 20.0 ft of soft to medium stiff clay but not more than 40.0 ft of soft clay.
The site factor shall be established from properly substantiated geotechnical data. In locations where the soil properties are not known in sufficient detail to determine the soil profile type, soil profile S3 shall be used. Soil profile S4 need not be assumed unless the Building Official determines that soil profile S4 may be present at the site, or in the event that soil profile S4 is established by geotechnical data.

City/Installation Database



Fields

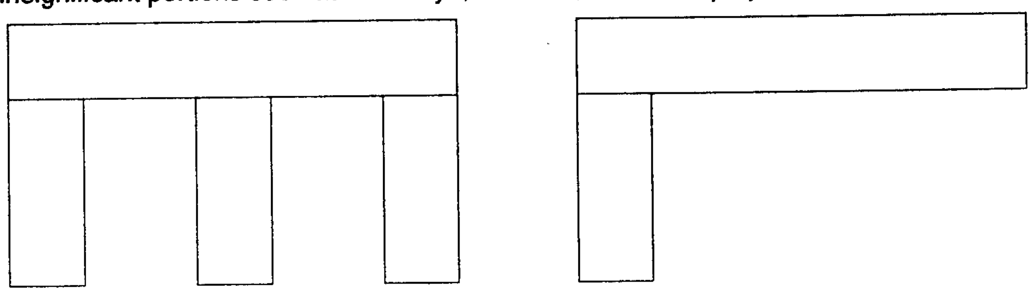
Country	State	*Metric*
County		
Design Load		
Elevation (ft)		
Ave. Rain (in)	Max. Rain (in)	
Ground Snow Load (psf)		
Max. Snow Depth (in)		
Basic Wind Speed (mph)		
Max. Wind Speed (mph)	Wind Direction	Coastal (Y/N)
Max. Temp. (°F)	Min. Temp. (°F)	
Frost Depth (in)	Seismic Zone	

Modeling Philosophy

A. Simplify the geometric model

For buildings with repetitive wings, only one wing needs to be modeled.

Insignificant portions such as chimneys, dormers, and small projections, should not be modeled.



Extra wings are not necessary

Simplified model

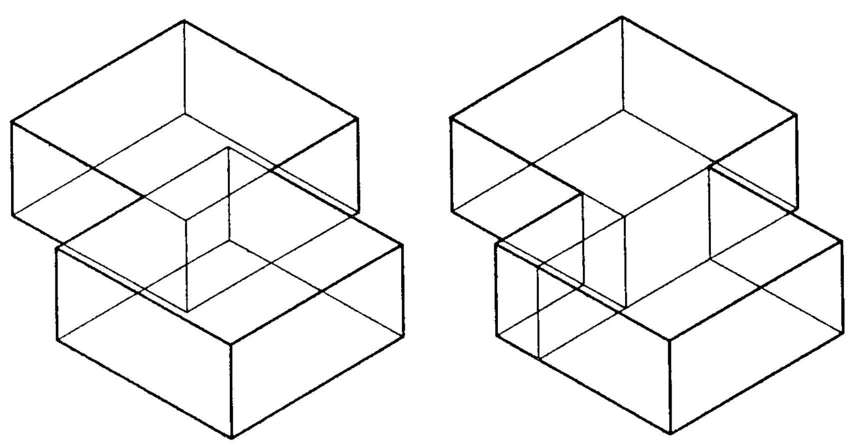
B. Make sure planes are in contact

A gap between adjoining shapes will make the surfaces exterior.

Use the Stack options to accurately place adjoining shapes.

C. Do not intersect shapes

When modeling parapet walls, make sure the corners do not intersect.



Incorrect

Correct

D. Verify the model

Use the Tape Measure command, zoom in on a plan, elevation and 3-D views to verify the model.

Draw Model

Start

Use Draw Model Tool Palette

Establish Initial Layout Defaults

Ground Plane
Size: 100' x 100'
Spacing: 20' x 20'
√ Show Ground Plane

Units
Increment: 4"
Display: US ft-in
√ Snap To Units

Initial Shape Size
N-S: 73'8"
E-W: 85'8"
Height: 14'0"
Plane Thickness: 10"
Orientation: N-S

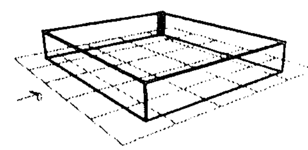
√ Stack On Ground Plane

Draw Building Volume

Draw First Floor Volume

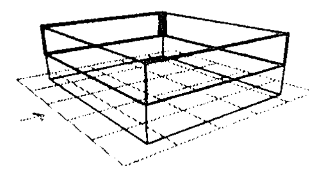
Position Cube On Ground Plane

Double Click Right Mouse Key To End



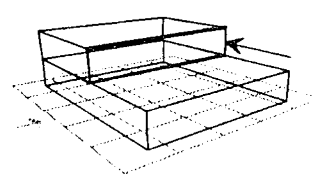
Draw Second Floor Volume

√ Stack On Last Shape



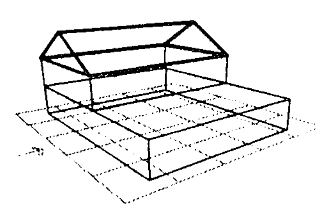
Place Cube On Last Shape

Drag Plane To Correct Dimension
E-W: 49'8"



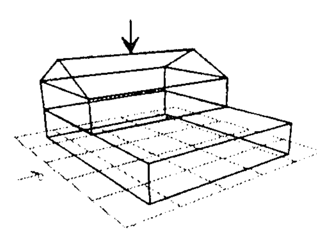
Draw Gable Roof Volume

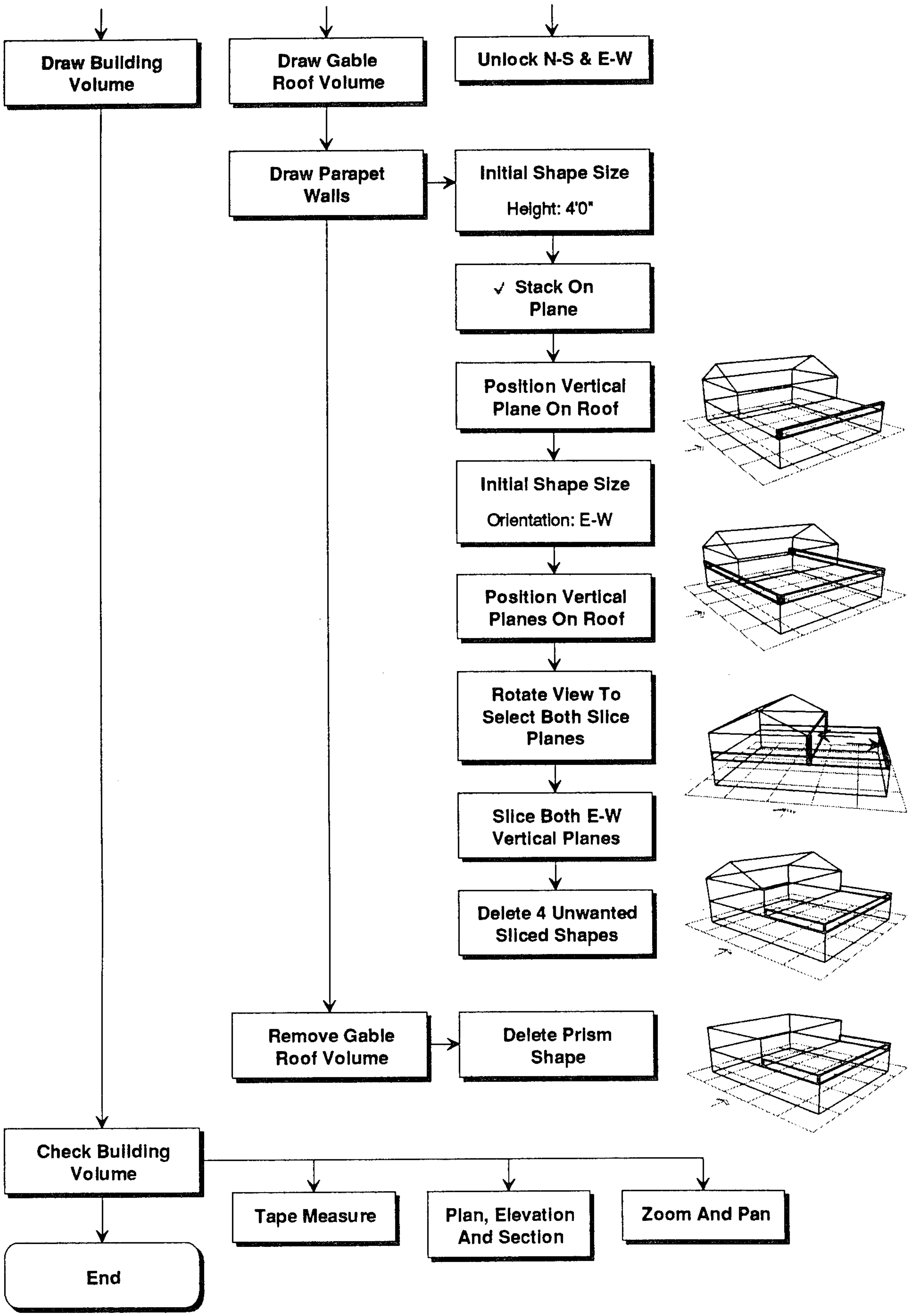
Place Prism On Last Shape

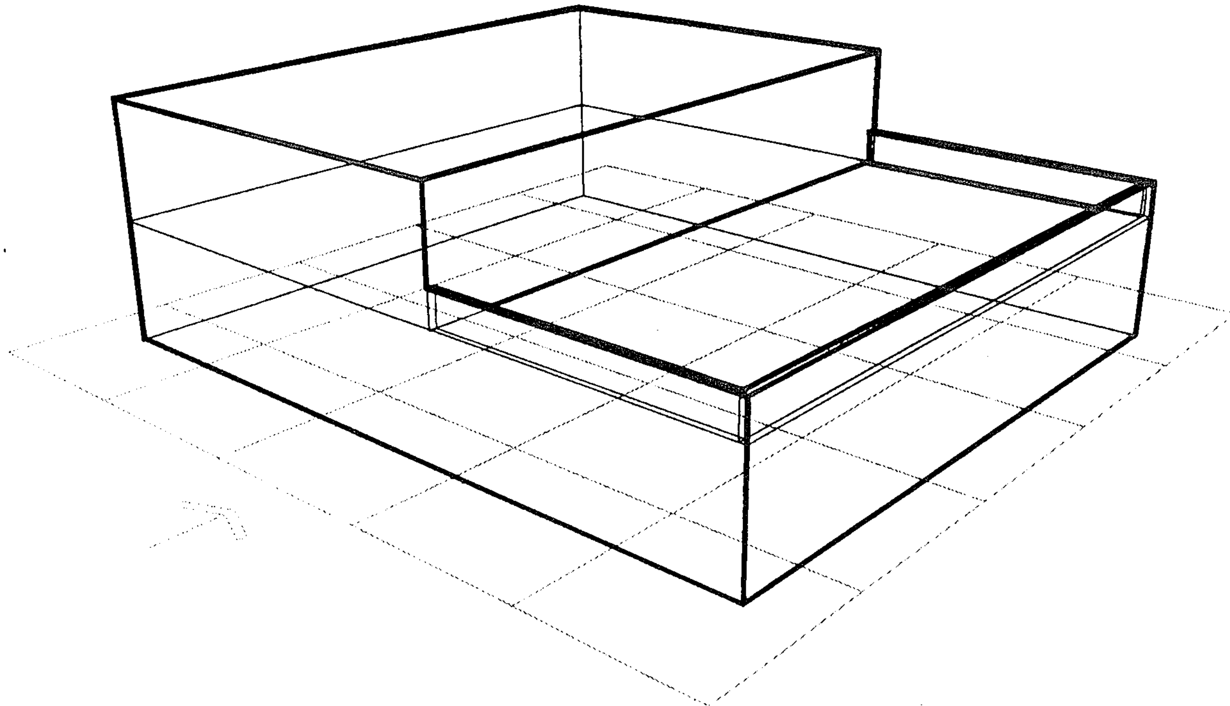


√ Lock N-S & E-W

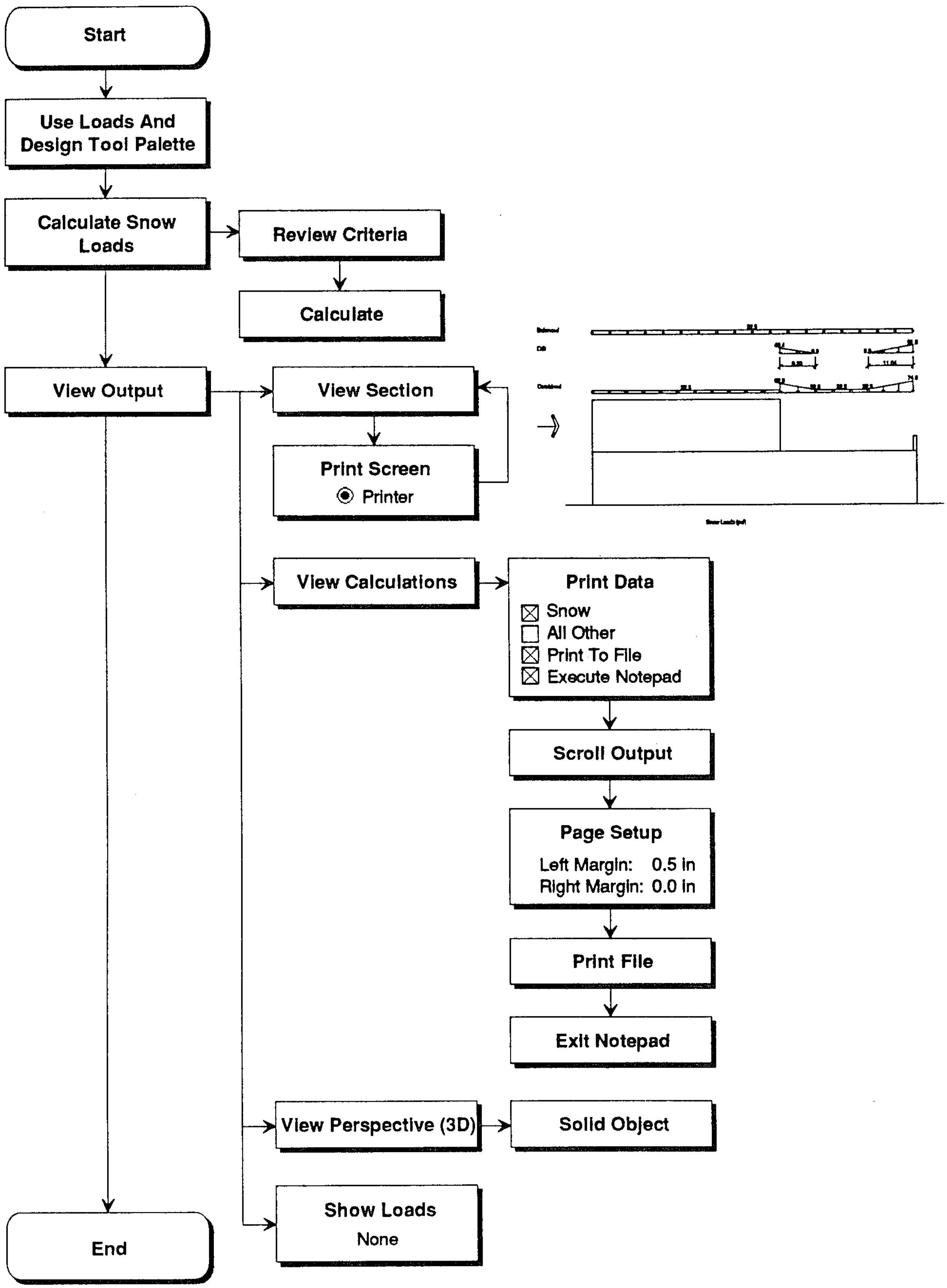
Drag Edge To Correct Roof Slope
Slope: 5.8 in 12



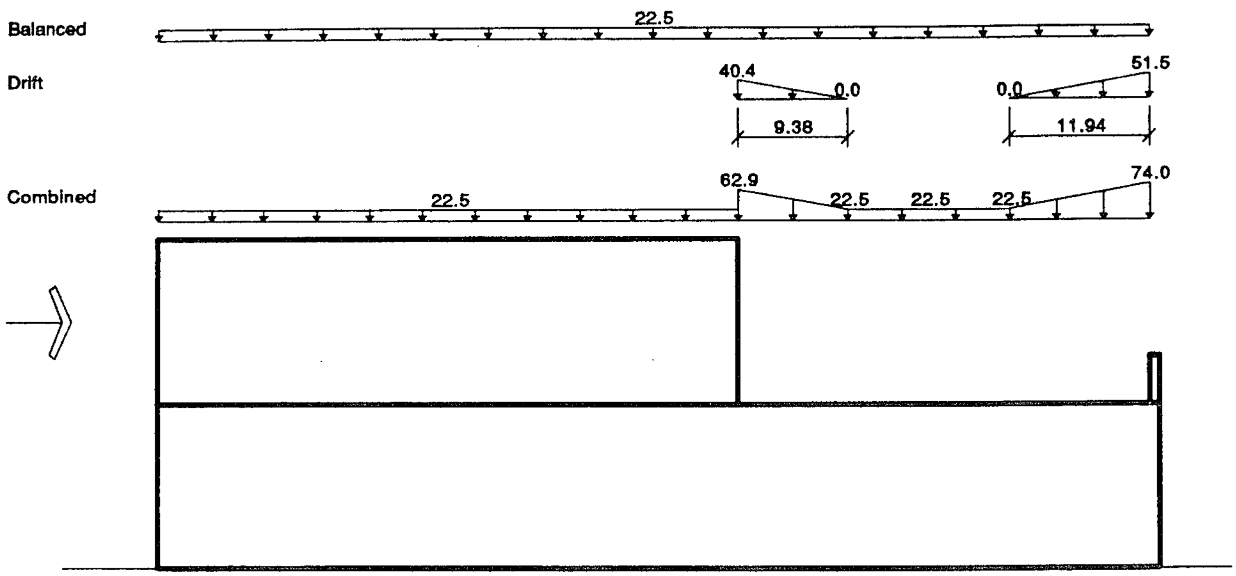

Draw Building Volume
Draw Gable Roof Volume
Unlock N-S & E-W
Draw Parapet Walls
Initial Shape Size
Height: 4'0"
✓ Stack On Plane
Position Vertical Plane On Roof
Initial Shape Size
Orientation: E-W
Position Vertical Planes On Roof
Rotate View To Select Both Slice Planes
Slice Both E-W Vertical Planes
Delete 4 Unwanted Sliced Shapes
Remove Gable Roof Volume
Delete Prism Shape
Check Building Volume
Tape Measure
Plan, Elevation And Section
Zoom And Pan
End



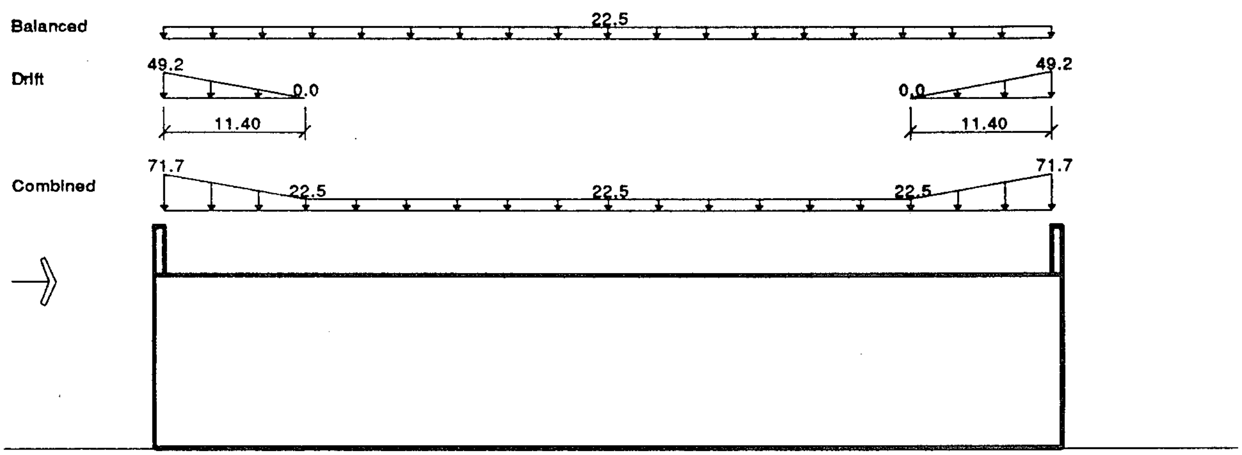
Snow Loads



Start
Use Loads And Design Tool Palette
Calculate Snow Loads
Review Criteria
Calculate
View Output
View Section
Print Screen
Printer
View Calculations
Print Data
Snow
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
None
End



Snow Loads (psf)



Snow Loads (psf)

```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Mon Aug 29, 1994  2:55 PM

******************* Flat/Lean-To Roof Snow Load Design *******************

Flat Roof Snow Load (Pf)
Pf = 0.7*Ce*Ct*I*Pg
Snow Exposure Category: C
Ce = 1.0
Heated Structure.
Ct = 1.0
Importance Category: I
I  = 1.0
Pg = 25.0 psf
Pf = 17.50 psf
Roof Slope: 0.00 in 12
Theta = 0 deg
Since theta < 0.5 in/ft, 5.0 psf rain-on-snow surcharge applies.
Pf = 22.50 psf
Check minimum Pf where theta <= 15 deg
When Pg > 20.0 psf, min Pf = 20.0*I
Min Pf = 20.00 psf
+-------------------------+
|     Pf = 22.50 psf      |
+-------------------------+

Sloped Roof Snow Load (Ps)
Ps = Cs*Pf
Roof Slippery: No
Cs = 1.00
+-------------------------+
|     Ps = 22.50 psf      |
+-------------------------+

************************* Drift Snow Load Design *************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.99 ft
hc/hb = 2.94 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 84.83 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 3.10 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 12.38 ft
w = 4*hc = 11.94 ft
+-------------------------+
|       W = 11.94 ft      |
+-------------------------+

hd = hd*(20.0-s)/20.0 = 3.10 ft
hd > hc, therefore hd = hc = 2.99 ft
Pd = hd*density
```

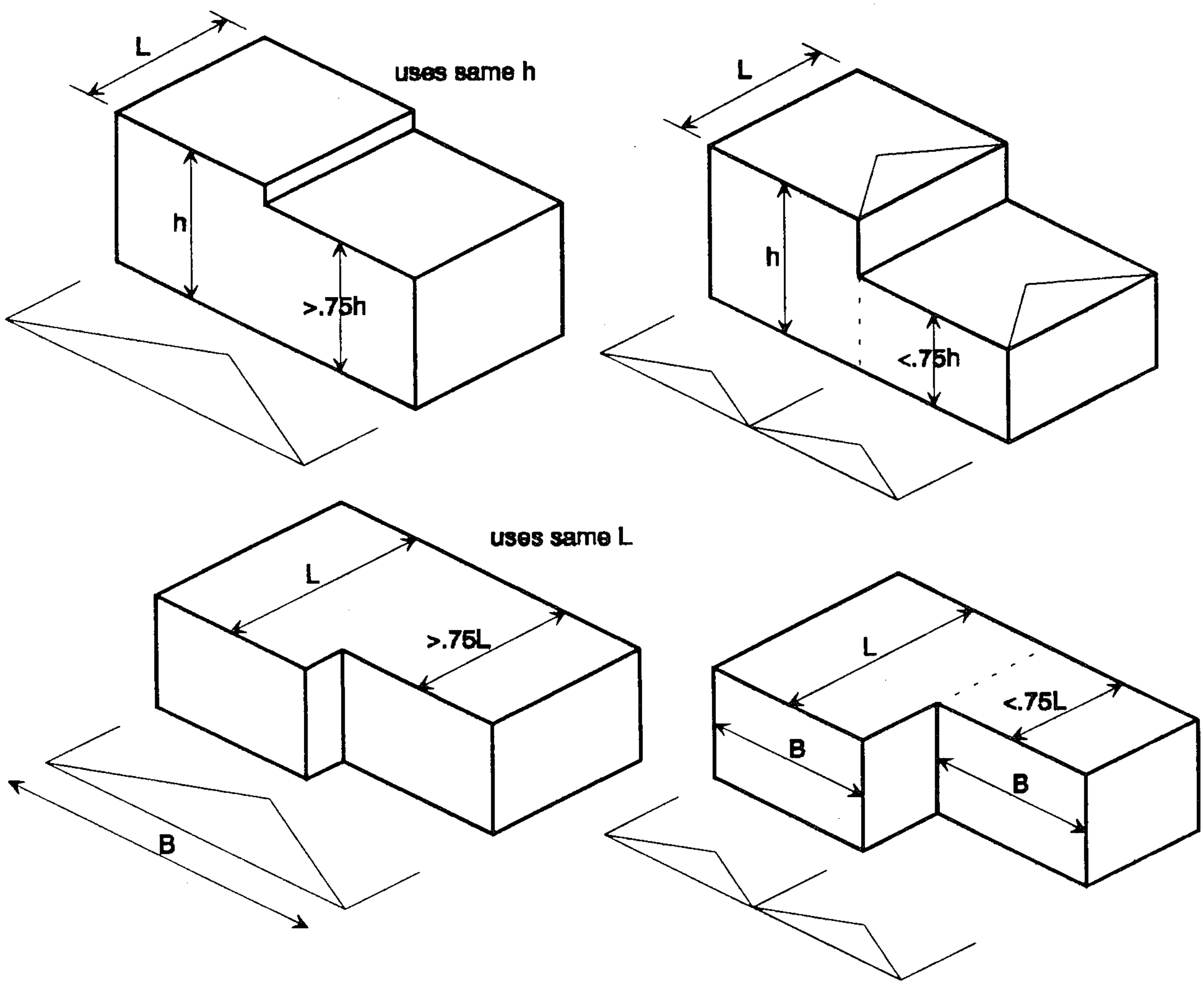
```
+------------------------+
|     Pd = 51.50 psf     |
+------------------------+

************************* Drift Snow Load Design *************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.99 ft
hc/hb = 2.94 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 72.00 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 2.85 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 11.40 ft
w = 4*hc = 11.94 ft
+------------------------+
|      W = 11.40 ft      |
+------------------------+

hd = hd*(20.0-s)/20.0 = 2.85 ft
hd <= hc
Pd = hd*density
+------------------------+
|     Pd = 49.18 psf     |
+------------------------+

************************* Drift Snow Load Design *************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 14.00 ft
hc = height-hb
hc = 12.99 ft
hc/hb = 12.80 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 49.67 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 2.34 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 9.38 ft
w = 4*hc = 51.94 ft
+------------------------+
|      W = 9.38 ft       |
+------------------------+

hd = hd*(20.0-s)/20.0 = 2.34 ft
hd <= hc
```

```
Pd = hd*density
+-------------------------+
|      Pd = 40.44 psf     |
+-------------------------+
```

Wind Assumptions

Proportions For B/L & h/L

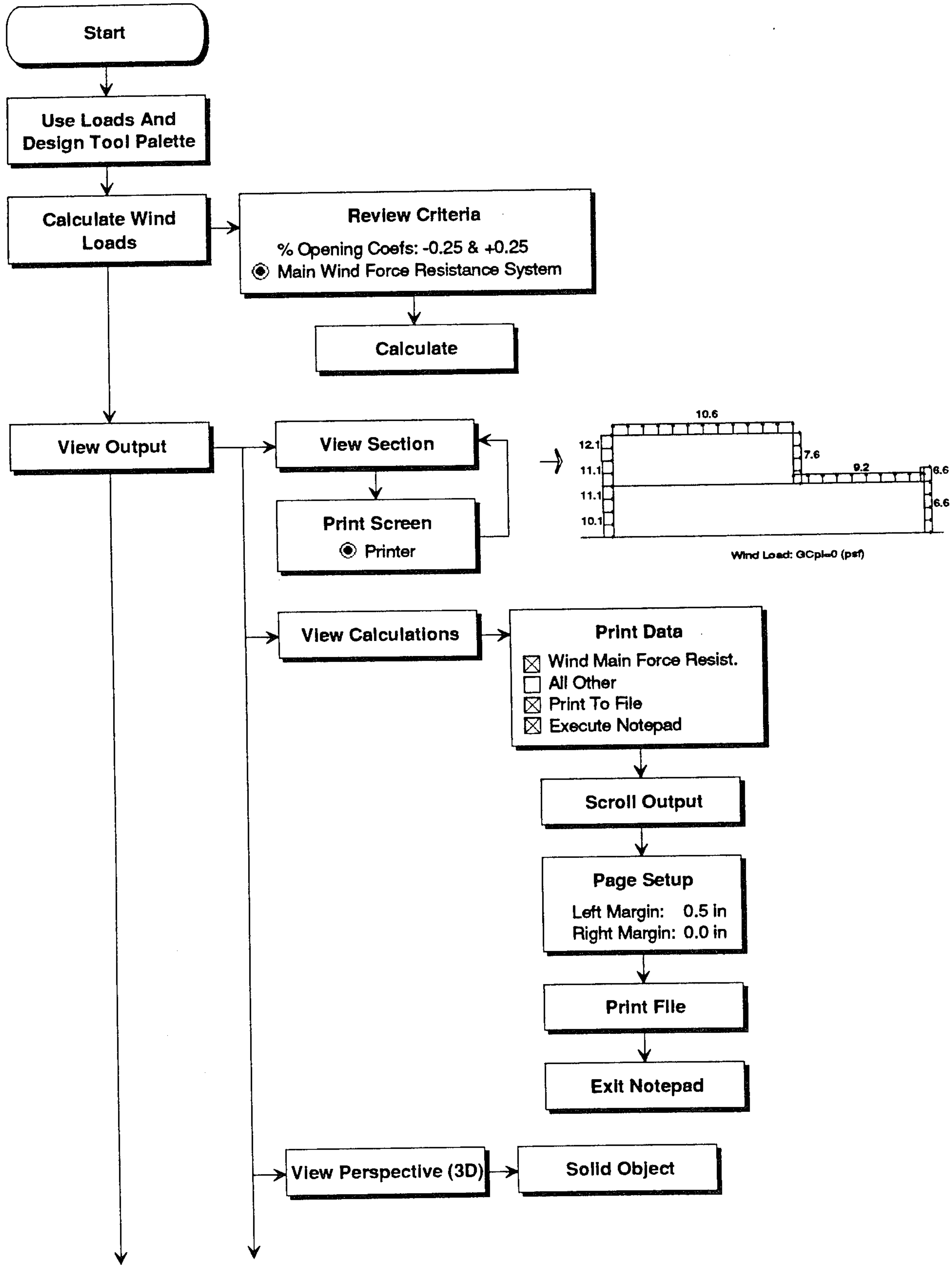
Defaults:	Height Ratio:	0.75
	Plan Ratio:	0.75

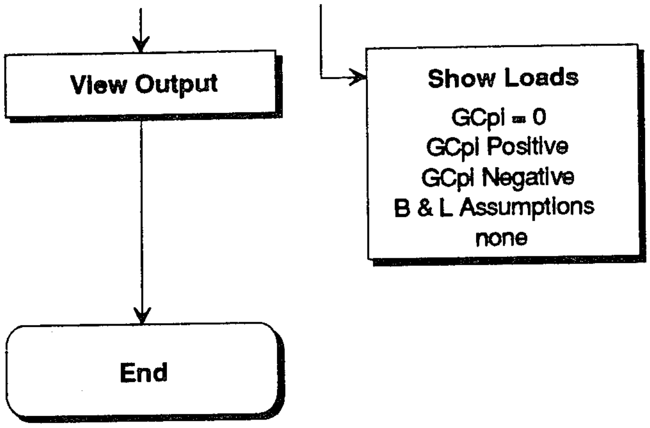


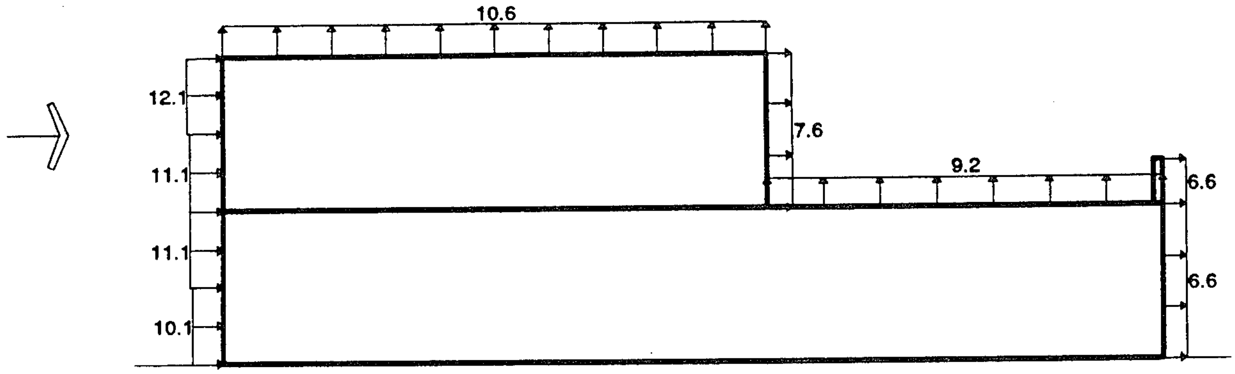
Building Height Maximum 60 Feet

Assumed for components and cladding

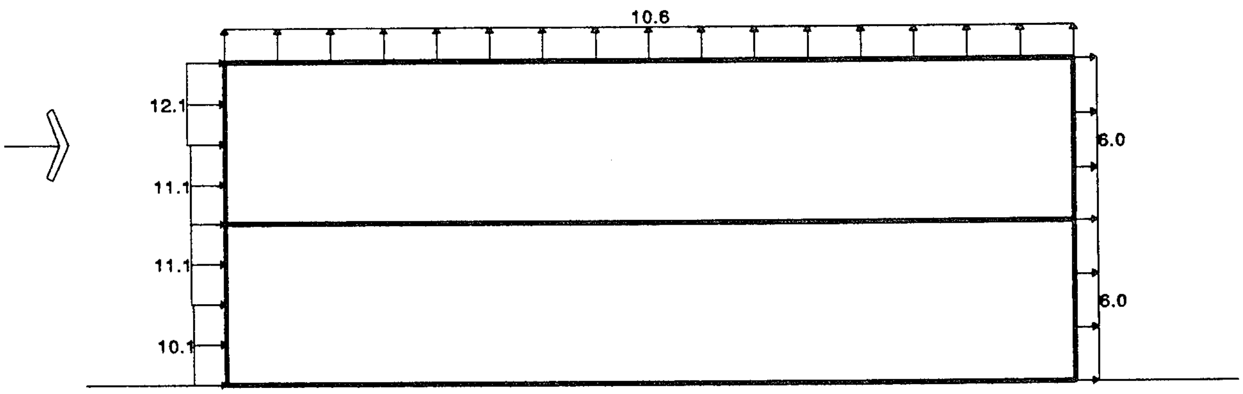
Main Wind Force Resisting Loads



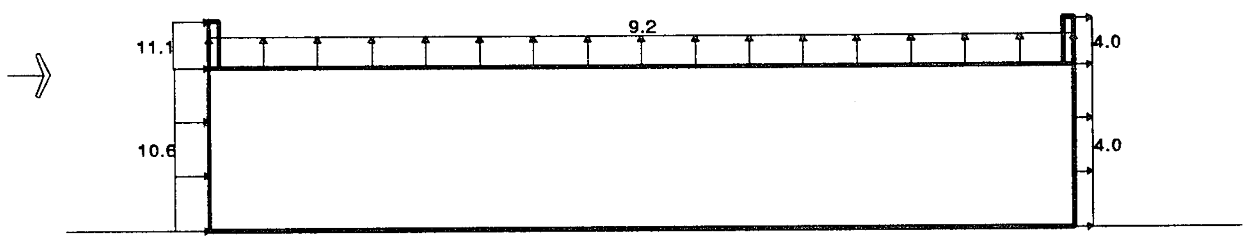

View Output
Show Loads
GCpi = 0
GCpi Positive
GCpi Negative
B & L Assumptions
none
End



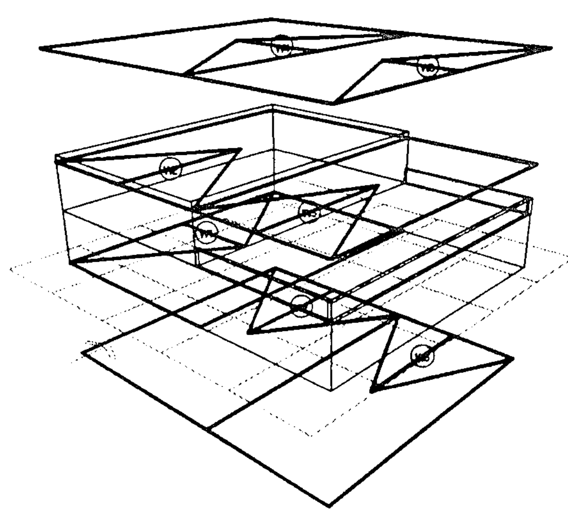
Wind Loads: GCpi=0 (psf)



Wind Loads: GCpi=0 (psf)



Wind Loads: GCpi=0 (psf)



Main Wind Force Resisting Loads

```
Project     : Office Building - Scheme A
Location    : Radford AAP
Design Load : TM 5-809-1 1992
Time        : Mon Aug 29, 1994  4:13 PM

****************************** Wind Load - 1 ******************************
```

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	49.7	

Distance to ocean line >= 100 mi   h/d = 0.56 <= 5

```
************************ Main Framing Pressures ************************
```

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 3	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1	14.1	8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6	-4.6	-10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

```
****************************** Wind Load - 2 ******************************
```

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	49.7	73.7	

Distance to ocean line >= 100 mi   h/d = 0.56 <= 5

```
************************ Main Framing Pressures ************************
```

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 3	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1	14.1	8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.40	-6.0	-3.0	-9.0
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

******************************* Wind Load - 3 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	36.0	

Distance to ocean line >= 100 mi   h/d = 0.39 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
parapet	18.0	1.32	0.84	10.5	0.80	11.1		
level 1	14.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
level 1	0.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
Leeward Wall	14.0	1.32	0.80	10.0	-0.50	-6.6	-4.1	-9.1
Side Wall	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Roof	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Overhang **	14.0		0.80	10.0	0.80	8.0		
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

******************************* Wind Load - 4 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	49.7	

Distance to ocean line >= 100 mi   h/d = 0.56 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 2	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 1 - 2	14.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6	-4.6	-10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

******************************* Wind Load - 5 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	36.0	73.7	

Distance to ocean line >= 100 mi   h/d = 0.39 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
parapet	18.0	1.32	0.84	10.5	0.80	11.1		
level 1	14.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
level 1	0.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
Leeward Wall	14.0	1.32	0.80	10.0	-0.30	-4.0	-1.5	-6.5
Side Wall	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Roof	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Overhang **	14.0		0.80	10.0	0.80	8.0		
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

Notes for main framing:

Positive pressures act toward surfaces.

Pressure or suction = P = q*Gh*Cp-qh*(GCpi)

q: qz for windward wall evaluated at height z.

qh for leeward wall, side walls, and roof evaluated at mean roof height.

** For roof overhangs: algebraically add this pressure to the above values. P = qh(GCp) = 0.8qh

Internal Pressure Coefficients for Buildings, GCpi:

	Condition	GCpi
Condition I	All conditions except as noted under condition II.	+0.25 -0.25
Condition II	Buildings in which both of the following are met: 1. Percentage of openings in one wall exceeds the sum of the percentages of openings in the remaining walls and roof surfaces by 5% or more, and 2. Percentage of openings in any one of the remaining walls or roof do not exceed 20%.	+0.75 -0.25

Notes:

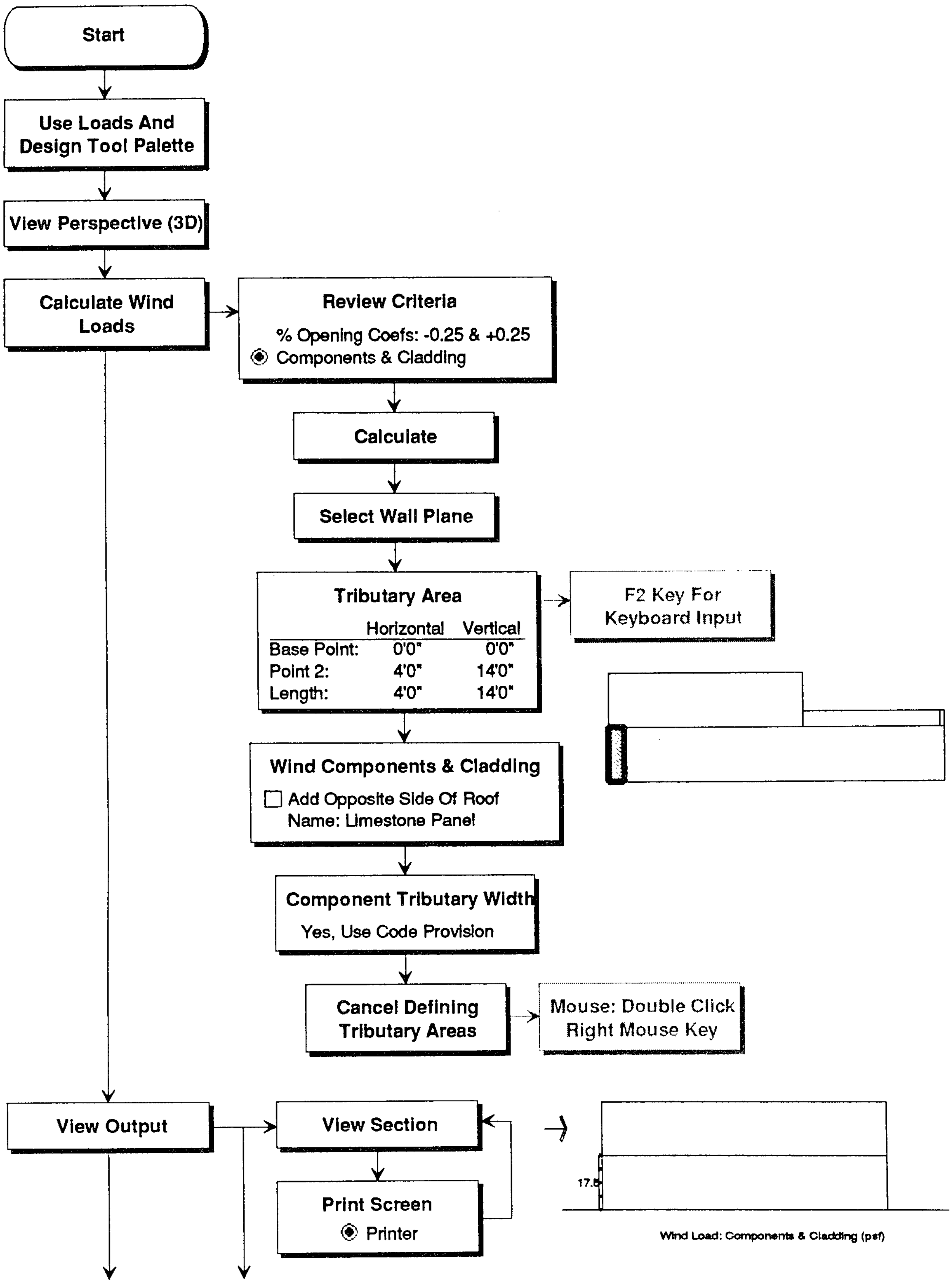
(1) Values are to be used with qz or qh as specified in Table 4.

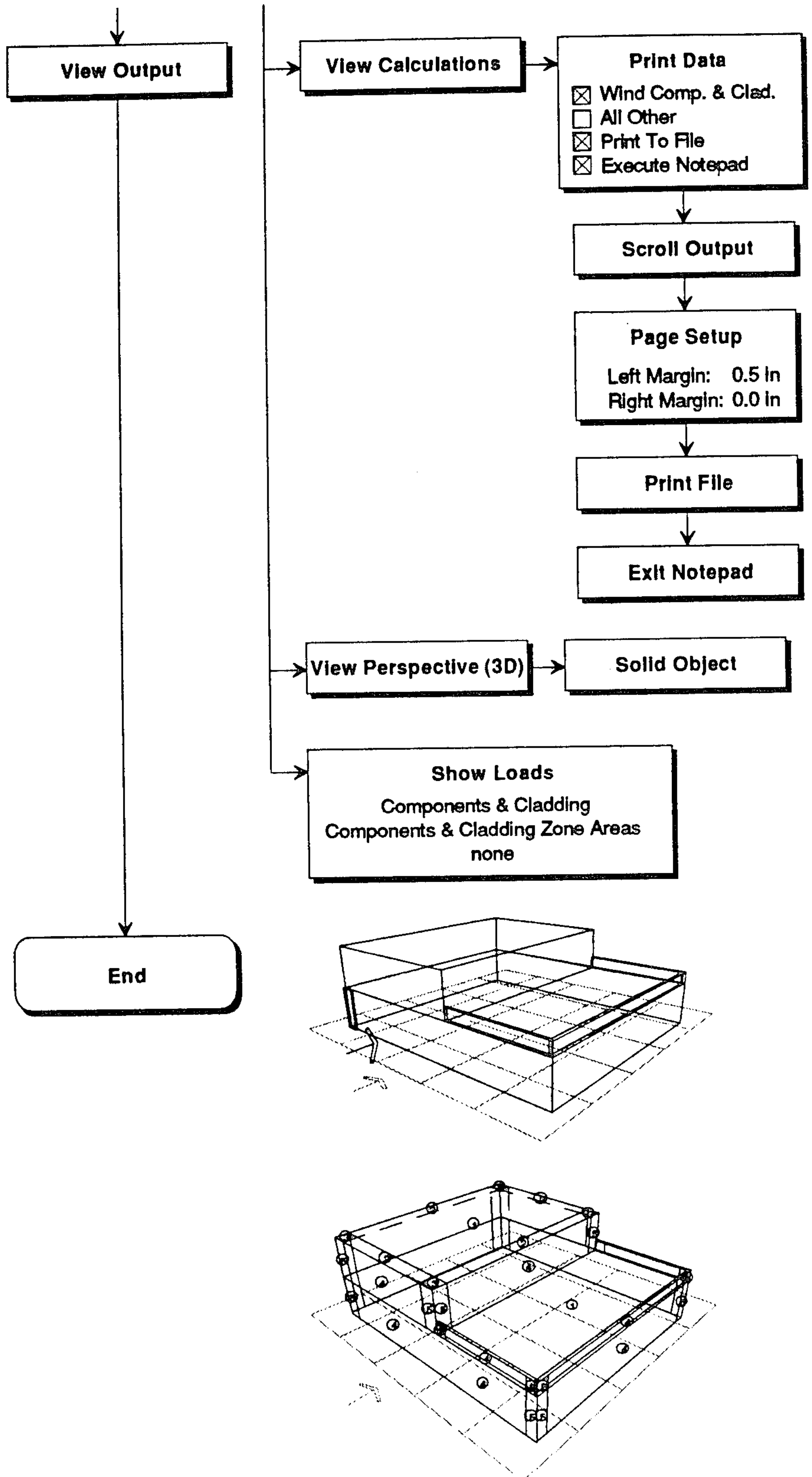
(2) Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.

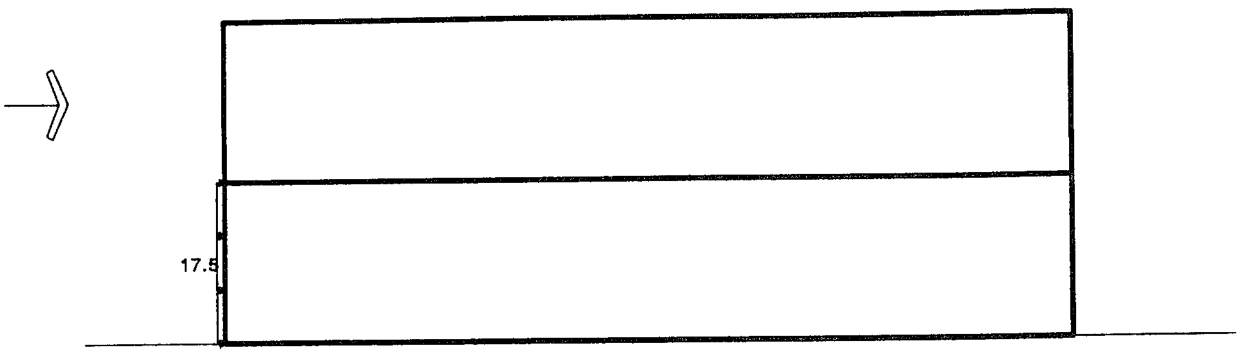
(3) To ascertain the critical load requirements for the appropriate condition, two cases shall be considered: a positive value of GCpi applied simultaneously to all surfaces, and a negative value of GCpi applied to all surfaces.

(4) Percentage of openings in a wall or roof surface is given by ratio of area of openings to gross area for the wall or roof surface considered.

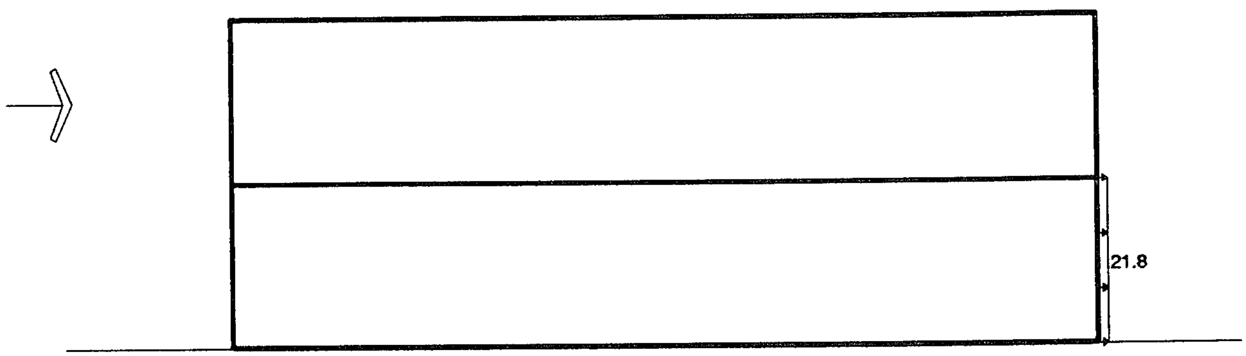
Wind Components & Cladding Loads



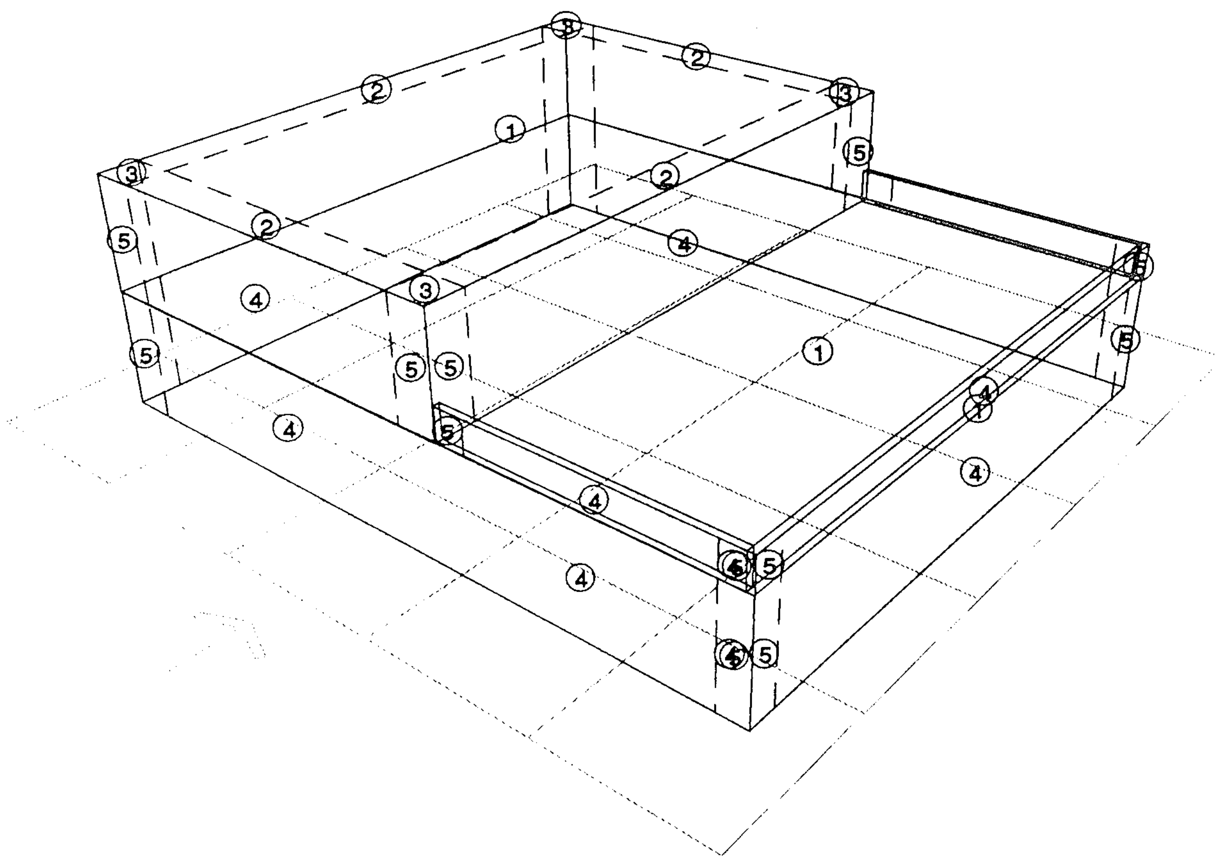

View Output
View Calculations
Print Data
☒ Wind Comp. & Clad.
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
Components & Cladding
Components & Cladding Zone Areas
none
End



Wind Loads: Components & Cladding (psf)



Wind Loads: Components & Cladding (psf)



Project   : Office Building - Scheme A
Location   : Radford AAP
Design Load : TM 5-809-1 1992
Time   : Mon Aug 29, 1994 4:32 PM

******************************** Wind Load ********************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	49.7	73.7	

Distance to ocean line >= 100 mi   h/d = 0.56 <= 5

Height (ft)	Kh	qh (psf)	GCpi	
28.0	0.96	12.0	-0.25	0.25

Height <= 60.0 ft

******************* Component/Cladding Pressures (psf) *******************

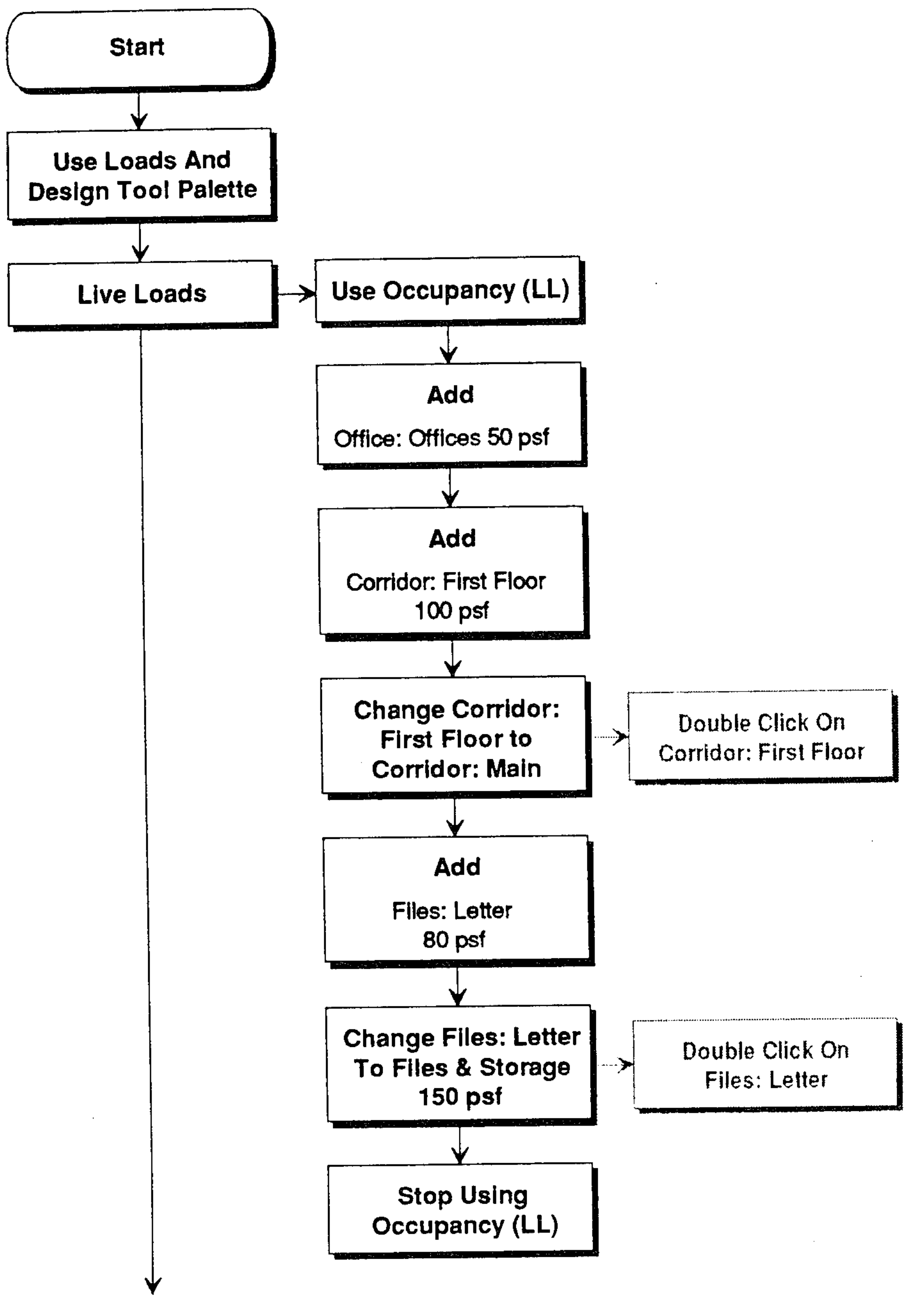
	Walls							
	Windward				Leeward			
Tributary Area (sf)	Zone 4 middles		Zone 5 corners		Zone 4 middles		Zone 5 corners	
	GCp	P	GCp	P	GCp	P	GCp	P
Internal		-3.0		-3.0		3.0		3.0
Limestone Panel 4.67 ft x 14.00 ft **								
65.3	1.21	17.5	1.21	17.5	-1.31	-18.7	-1.57	-21.8
				a = 5.0 ft				

Notes for components and cladding:
P = qh(GCp)-qh(GCpi)
Internal pressures have been included in above values.
To comply with TM 5-809-1, wall external pressures have not been reduced 10% per ASCE figure 3, note 3.
** For a rectangular tributary area, the width of the area need not be less than one-third the length of the area.
Internal Pressure Coefficients for Buildings, GCpi:

	Condition	GCpi
Condition I	All conditions except as noted under condition II.	+0.25 -0.25
Condition II	Buildings in which both of the following are met: 1. Percentage of openings in one wall exceeds the sum of the percentages of openings in the remaining walls and roof surfaces by 5% or more, and 2. Percentage of openings in any one of the remaining walls or roof do not exceed 20%.	+0.75 -0.25

Notes:
(1) Values are to be used with qz or qh as specified in Table 4.
(2) Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
(3) To ascertain the critical load requirements for the appropriate condition, two cases shall be considered: a positive value of GCpi applied simultaneously to all surfaces, and a negative value of GCpi applied to all surfaces.
(4) Percentage of openings in a wall or roof surface is given by ratio of area of openings to gross area for the wall or roof surface considered.

Dead & Live Loads



Dead Loads → **Floor Dead Loads** → **Use Floor (DL)**

Input

Name: Second Floor

	Type	psf
Partition:	51-100 plf	6.0
Finish:	Carpet & Pad	1.0
Deck:	MTL DK 2.0/NLWT 2.5	42.0
Structure:	Steel Beams	0.0
Mechanical:	Mech A/C Ducts	3.0
Electrical:	Elect/Lighting	1.0
Fire Protection:	Sprinklers Wet	2.0
Ceiling:	Susp Chnl/Tile	2.0
Total:		57.0

Select Type Button → Scroll To Find Load Type & PSF → Double Click On Load Type

Stop Using Floor (DL)

Roof Dead Loads → **Use Roof (DL)**

Input

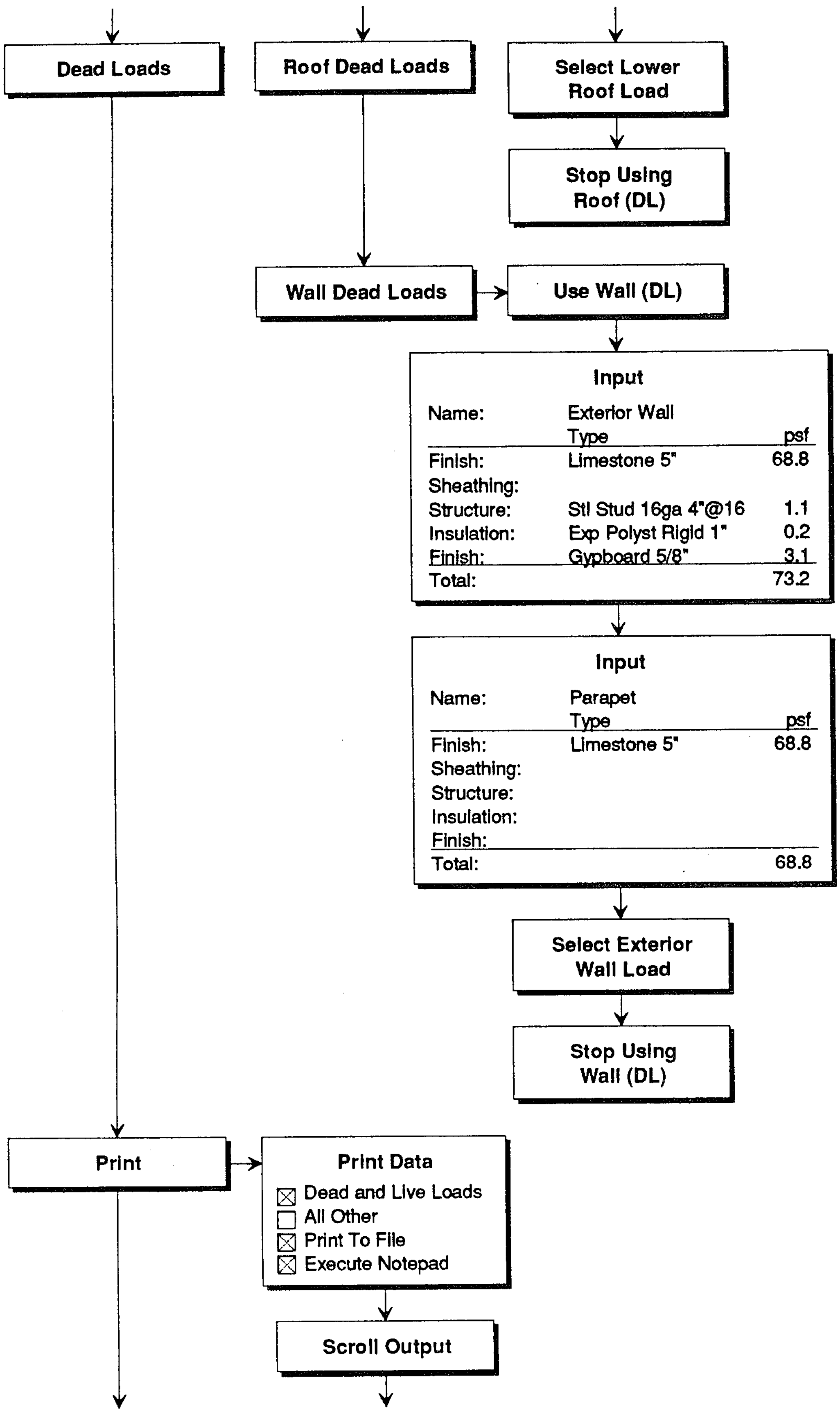
Name: Lower Roof

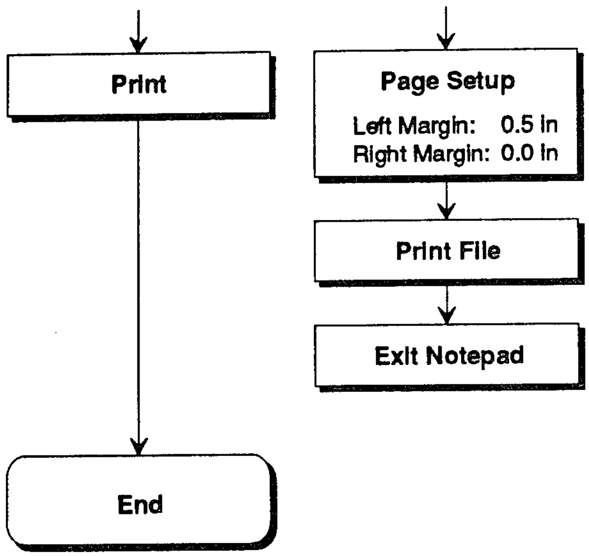
	Type	psf
Roofing:	Single Ply	1.5
Deck:	MTL DK 1.5/NLWT 2.5	36.0
Structure:	Steel Bar Jst 24'@4'	1.8
Mechanical:	Mech A/C Ducts	3.0
Electrical:	Elect/Lighting	1.0
Fire Protection:	Sprinklers Wet	2.0
Insulation:	Rigid Roof Ins 3"	2.4
Ceiling:		
Total:		47.7

Input

Name: Upper Roof

	Type	psf
Roofing:	Single Ply	1.5
Deck:	Steel 1-1/2" 20ga	2.5
Structure:	Steel Beams	0.0
Mechanical:	Mech A/C Ducts	3.0
Electrical:	Elect/Lighting	1.0
Fire Protection:	Sprinklers Wet	2.0
Insulation:	Rigid Roof Ins 3"	2.4
Ceiling:	Susp Chnl/Tile	2.0
Total:		14.4


Dead Loads
Roof Dead Loads
Select Lower Roof Load
Stop Using Roof (DL)
Wall Dead Loads
Use Wall (DL)
Input
Name: Exterior Wall
Type psf
Finish: Limestone 5" 68.8
Sheathing:
Structure: Stl Stud 16ga 4"@16 1.1
Insulation: Exp Polyst Rigid 1" 0.2
Finish: Gypboard 5/8" 3.1
Total: 73.2
Input
Name: Parapet
Type psf
Finish: Limestone 5" 68.8
Sheathing:
Structure:
Insulation:
Finish:
Total: 68.8
Select Exterior Wall Load
Stop Using Wall (DL)
Print
Print Data
☒ Dead and Live Loads
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output


Print
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Loads

Floor Dead Loads

Name : Second Floor

	Type	psf
Partition	: 51-100 plf	6.0
Finish	: Carpet & Pad	1.0
Deck	: MTL DK 2.0/NLWT 2.5	42.0
Structure	: Steel Beams	0.0
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Ceiling	: Susp Chnl/Tile	2.0
Total	:	57.0

Roof Dead Loads

Name : Lower Roof

	Type	psf
Roofing	: Single Ply	1.5
Deck	: MTL DK 1.5/NLWT 2.5	36.0
Structure	: Steel Bar Jst 24'@4'	1.8
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Insulation	: Rigid Roof Ins 3"	2.4
Ceiling	:	0.0
Total	:	47.7

Name : Upper Roof

	Type	psf
Roofing	: Single Ply	1.5
Deck	: Steel 1-1/2" 20ga	2.5
Structure	: Steel Beams	0.0
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Insulation	: Rigid Roof Ins 3"	2.4
Ceiling	: Susp Chnl/Tile	2.0
Total	:	14.4

Wall Dead Loads

Name : Exterior Wall

	Type	psf
Finish	: Limestone 5"	68.8
Sheathing	:	0.0
Structure	: Stl Stud 16ga 4"@16	1.1
Insulation	: Exp Polysty Rigid 1"	0.2
Finish	: Gypboard 5/8"	3.1
Total	:	73.2

Name : Parapet

	Type	psf
Finish	: Limestone 5"	68.8
Sheathing	:	0.0
Structure	:	0.0
Insulation	:	0.0
Finish	:	0.0
Total	:	68.8

Occupancy Live Loads

Name	psf
Office: Offices	50
Corridor: Main	100
Files & Storage	150 a

a. These design loads are extremely variable. The design load will be increased when data is available.

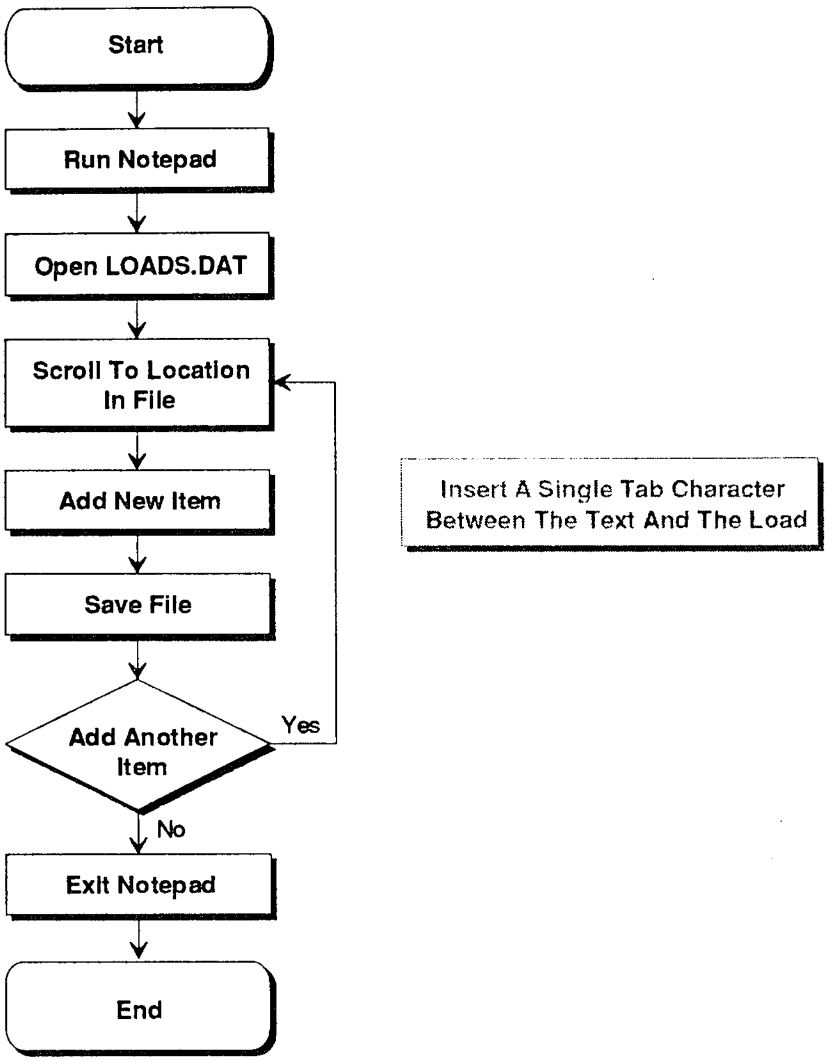
Notes

Uniformly distributed live loads for supporting members; i.e., two-way slab, beam, girder or columns having an influence area of 400.0 sqft or more may be reduced with: L = Lo*[0.25+(15/sqrt(Ai))]
The reduced design live load will not be less than 50% of the unit live load for members supporting one floor, nor less than 40% of the unit live load for members supporting two or more floors.
Exceptions: For live loads less than 100 psf, no reduction is permitted for members supporting floor(s) in the following areas:

- -public assembly
- -garages [except where 2 or more floors are supported]
- -one-way slab floor

For live loads greater than 100 psf and for garages used for passenger cars only, no reduction is permitted for members supporting one floor; however, where two or more floors are supported, a 20% reduction is permitted.

Loads Database



Draw Grid & Openings

Start

Use Draw Structure Tool Palette

Define Structural Grid

Select Second Floor/ Lower Roof Horizontal Structural Plane

Structural Plane Information

Name: Second Floor/Lower Roof

Close Structural Plane Information Dialog Window

Define Grid

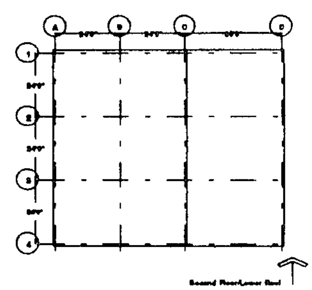
N-S Spacing: 24'0"
E-W Spacing: 24'0"
Perimeter Offset: 10"

Delete Grid Lines D & E

Delete Grid Lines

Select Grid Line E Then D

Double Click Right Mouse Key To End Deleting Grid Lines

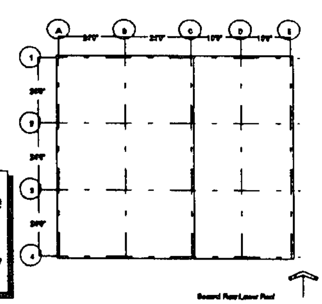


Add Main Grid Line Between C & D

Add Main Grid Line

Select Handle Between C & D

Keep Dimensions To The Left & Right At 18' And Click The Left Mouse Key



Draw Openings

Add Opening

	Horizontal	Vertical
Base Point:	10"	24'10"
Point 2:	8'10"	48'10"
Length:	8'0"	24'0"

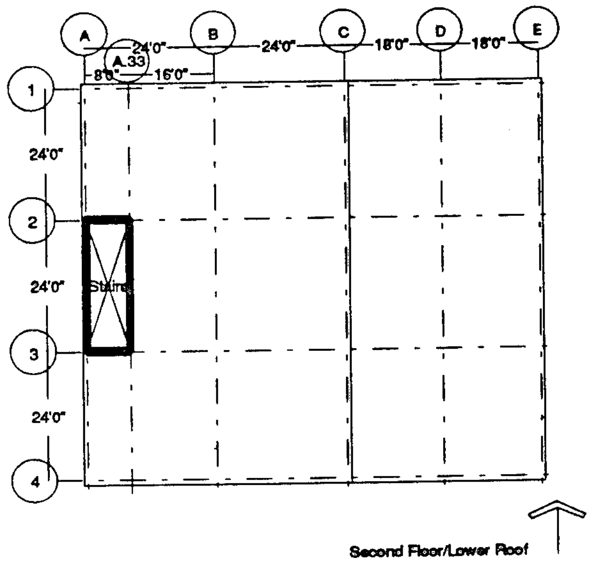
F2 Key For Keyboard Input

Opening

Name: Stairs

☐ Continuous

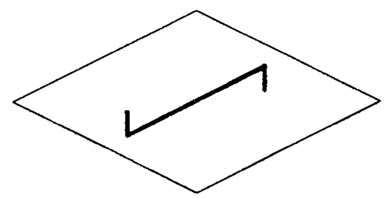
End



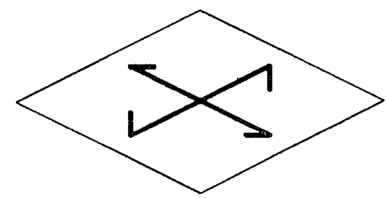
Draw Structure Philosophy

Structure Hierarchy

Surface/Deck
(horizontal)



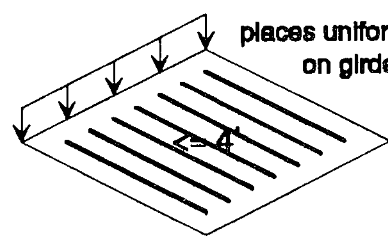
1 way



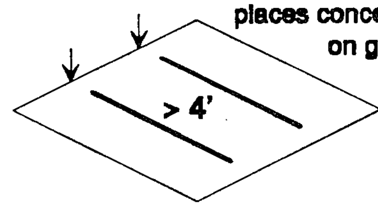
2 way
(not activated)

Linear
(horizontal)

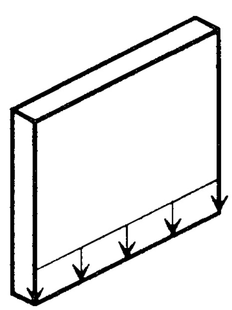
Narrowly Spaced
(joists)



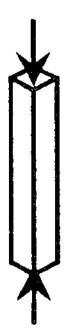
Widely Spaced
(beams)



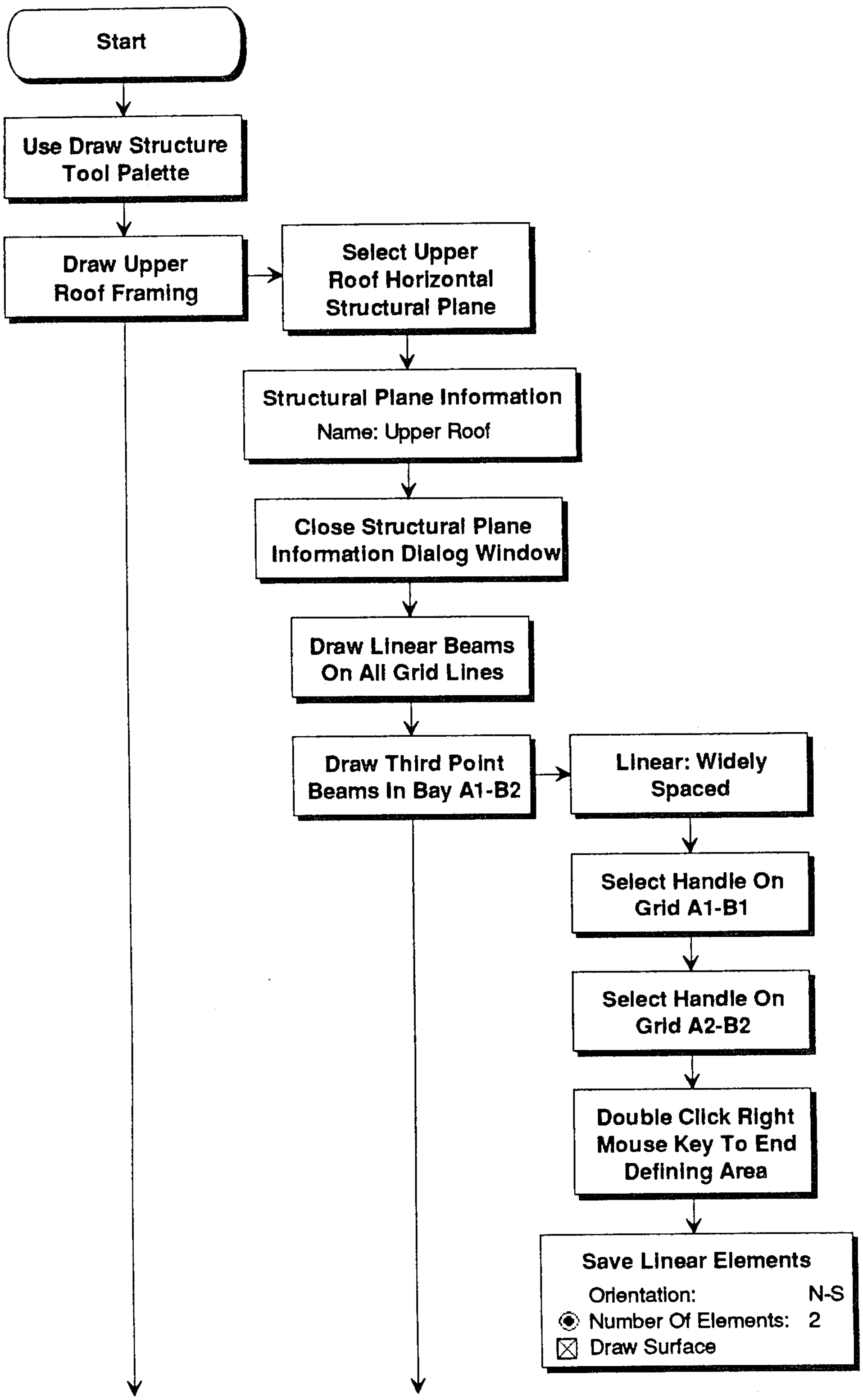
Surface
(vertical)
(planar)

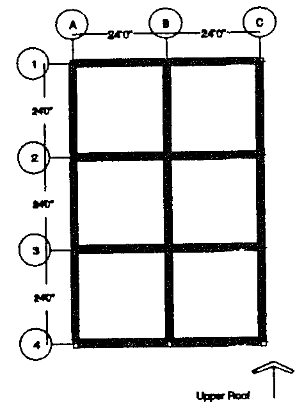


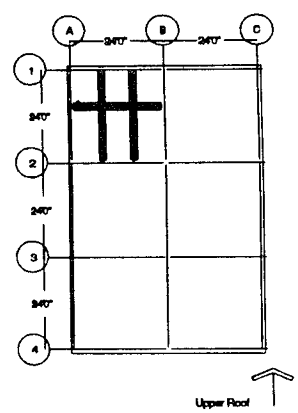
Linear
(vertical)



Draw Structure





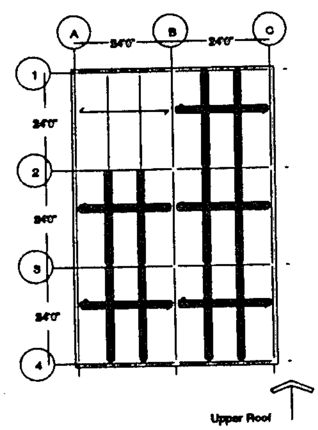


Draw Upper Roof framing → Draw Second Floor/ Lower Roof Framing

Copy Beams & One-Way Surface To Other Bays → Draw Columns

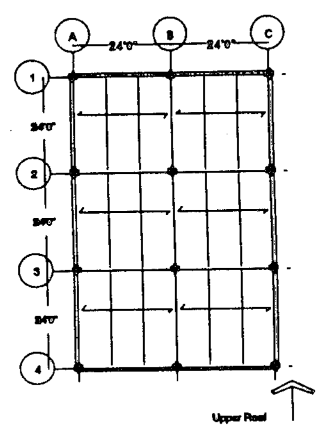
Copy Beams & One-Way Surface To Other Bays → Copy Structure

Copy Structure → Select Third Point Beams → Select One-Way Surface → Double Click Right Mouse Key To End Selecting Structure → Select Grid Location A1 As The Base Point → Paste Structure → Select Grid Locations B1, A2, B2, A3, B3 → Double Click Right Mouse Key To End



Draw Columns → Column All Grid Intersections → Save Column Elements

Save Column Elements
Orientation: N-S
☒ All Floors



Draw Second Floor/ Lower Roof Framing → Select Second Floor/ Lower Roof Horizontal Structural Plane

Select Second Floor/ Lower Roof Horizontal Structural Plane → Draw Linear Beams On All Grid Lines

Draw Second Floor/ Lower Roof Framing

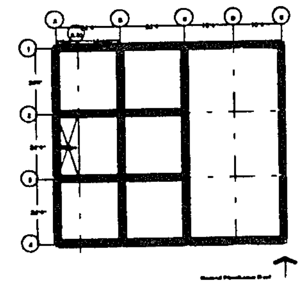
Delete Beams At Grid Locations Inside C1-E4

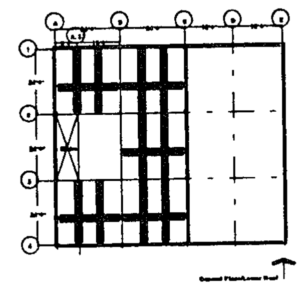
Draw Third Point Beams And One-Way Surface In Bays A1-B2, B1-C2, B2-C3, A3-B4, B3-C4

Paste Structure

Select Grid Locations A1, B1, B2, A3, B3

Double Click Right Mouse Key To End





Draw Third Point Beams In Bay A2-B3

Linear: Widely Spaced

Select Handle On Grid B2-B3

Select Handle On Grid A2-A3

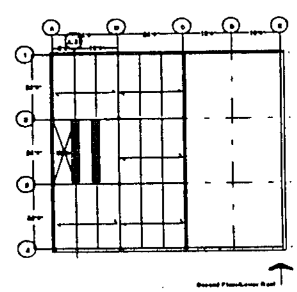
Double Click Right Mouse Key To End Defining Area

Save Linear Elements

Orientation: N-S

◉ Number Of Elements: 2

☐ Draw Surface



Draw Surface In Bay A.33,2-B3

Surface: One-Way

Select Handle On Grid A.33,2-A.33,3

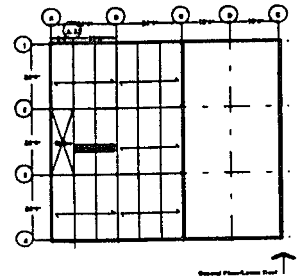
Select Handle On Grid Line B2-B3

Draw Second Floor/ Lower Roof Framing

Draw Surface In Bay A.33,2-B3

Double Click Right Mouse Key To End Defining Area

Save Surface Element
Orientation: E-W



Draw Joists In Bay C1-E2

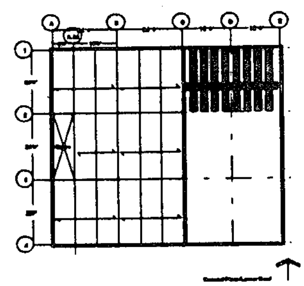
Linear: Narrowly Spaced

Select Handle On Grid C1-C2

Select Handle On Grid E1-E2

Double Click Right Mouse Key To End Defining Area

Save Linear Elements
Orientation: N-S
◉ Spacing: 48"
☒ Draw Surface



Copy Joists & One-Way Surface To Other Bays

Copy Structure

Select Joists

Select One-Way Surface

Double Click Right Mouse Key To End Selecting Structure

Draw Second Floor/ Lower Roof Framing

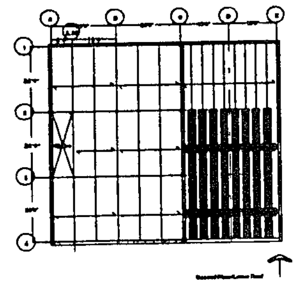
Copy Joists & One-Way Surface To Other Bays

Select Grid Location C1 As The Base Point

Paste Structure

Select Grid Locations C2, C3

Double Click Right Mouse Key To End



Draw Trusses

Linear Truss-Custom

Select Grid Locations C2-D2, D2-E2

Double Click Right Mouse Key To End Defining Area

Save Linear Elements

Orientation: E-W

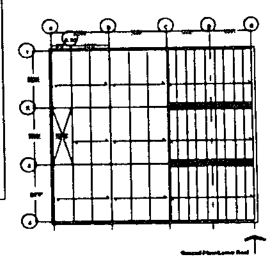
Truss-Custom

☐ Include Opposite Side Of Roof

Depth Of Support: 3'

Scissors Height: 0'

Repeat For Grid Location C3-E3



Draw Columns

Column One Grid Intersection

Select Grid Locations D1, E1, E2, E3, D4, E4

Draw Second Floor/ Lower Roof Framing

Draw Columns

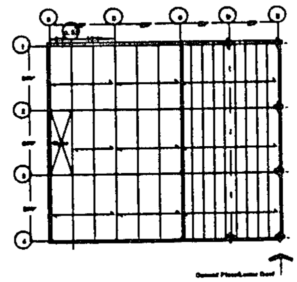
Double Click Right Mouse Key To End Selecting Locations

Save Columns

Orientation: N-S

Height: 14'

☐ All Floors



View Structure

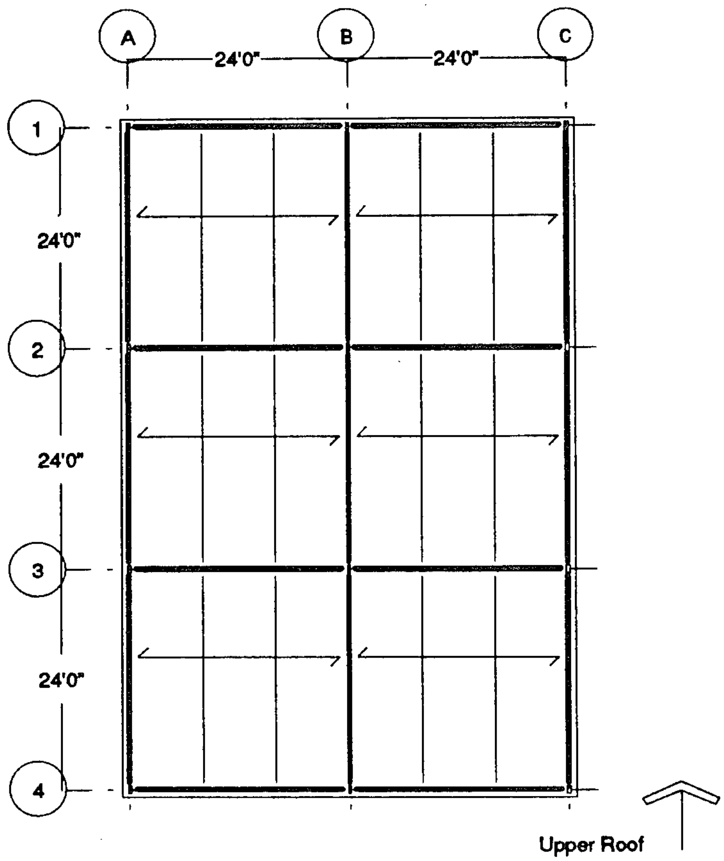
Show Structure

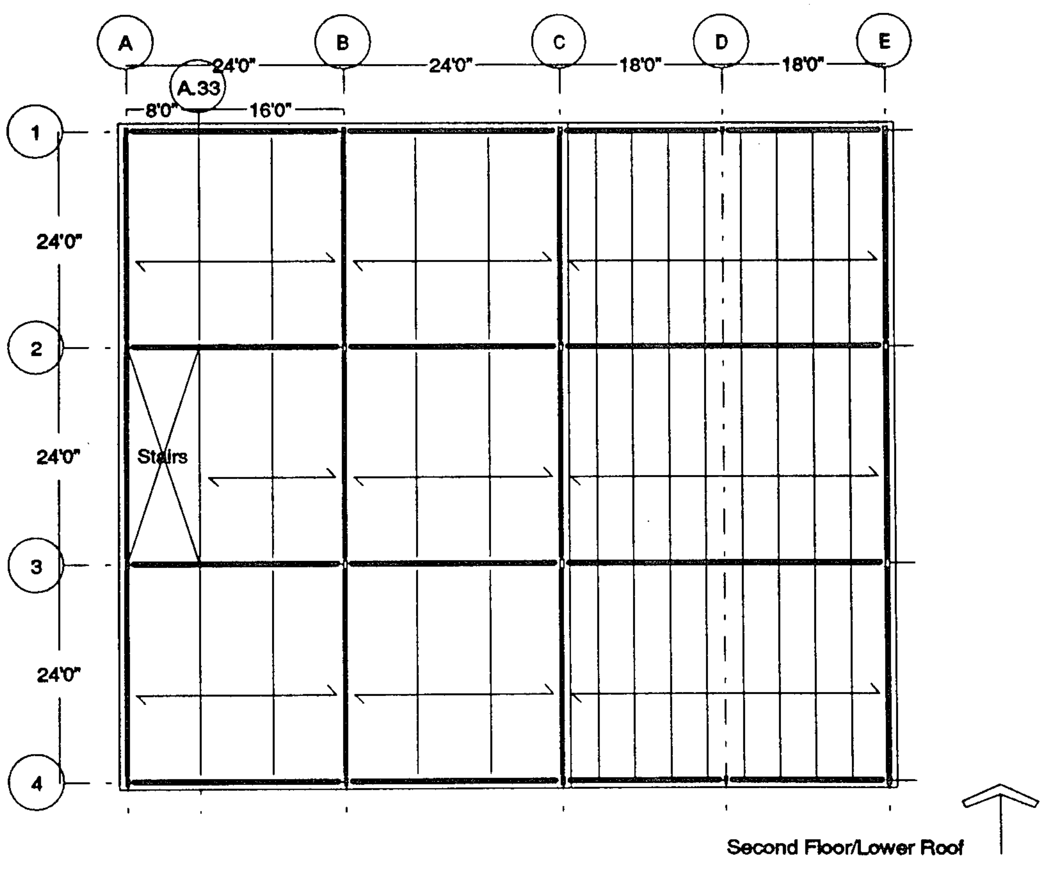
☒ All Planes

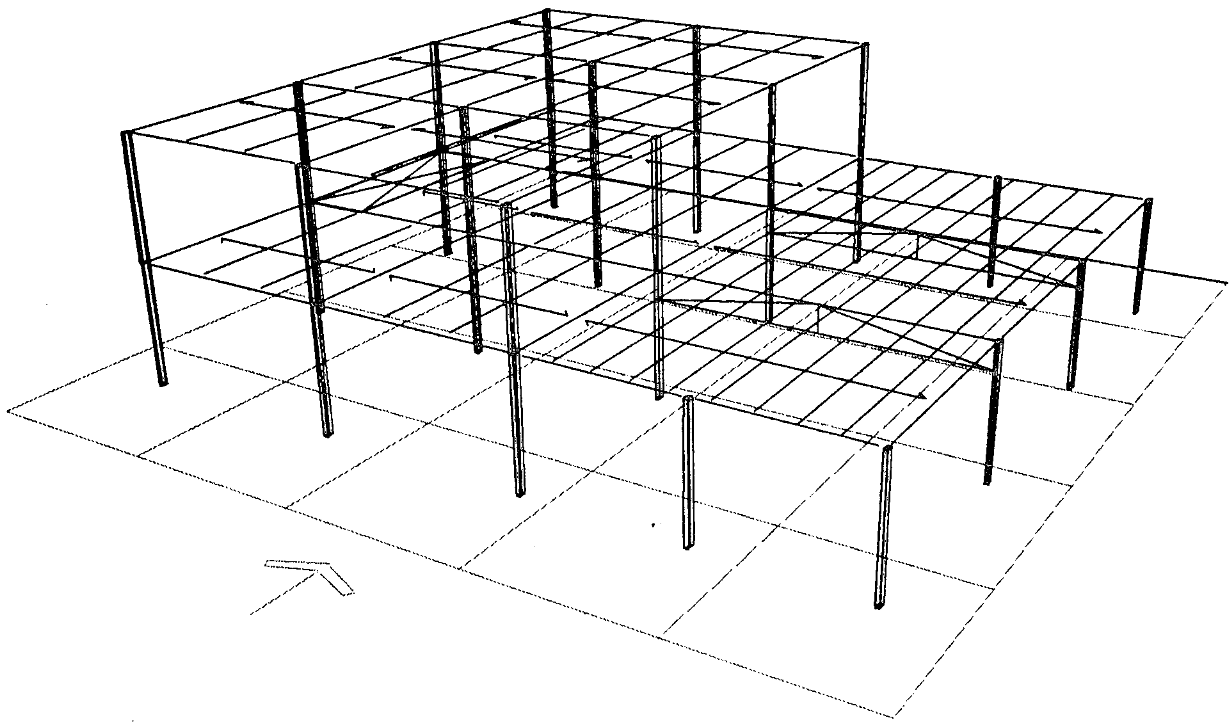
Perspective (3D)

Transparent Object

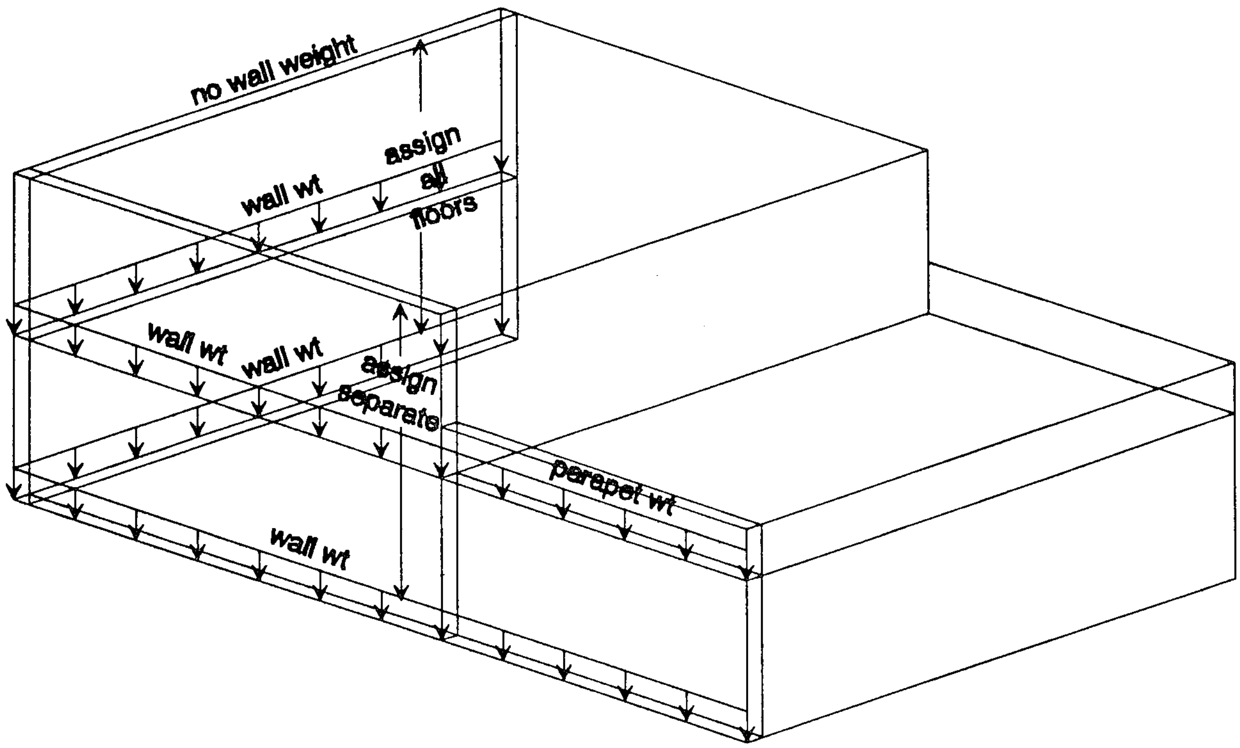
End

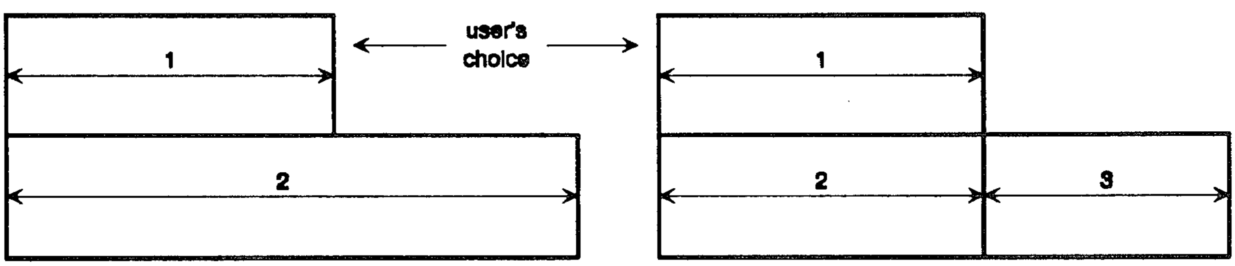

A
B
C
24'0"
24'0"
1
2
3
4
24'0"
24'0"
24'0"
Upper Roof


A
B
C
D
E
24'0"
24'0"
18'0"
18'0"
A.33
8'0"
16'0"
1
2
3
4
24'0"
24'0"
24'0"
Stairs
Second Floor/Lower Roof



Assign Wall Loads Philosophy





this appproach saves memory

Assign Loads

Start

↓

Use Loads & Design Tool Palette

↓

Assign Live Loads → Select Second Floor/ Lower Roof Horizontal Structural Plane

↓

Use Occupancy (LL)

↓

Highlight: Offices 50 psf

↓

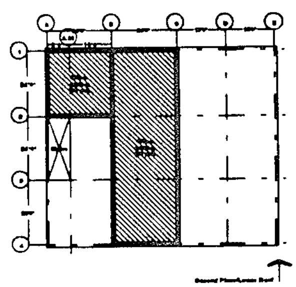
Assign Offices 50 psf → Snap To Grid; F2 Key For Keyboard Input

	Horizontal	Vertical
Base Point:	24'10"	10"
Point 2:	48'10"	72'10"
Length:	24'0"	72'0"

↓

Assign Offices 50 psf

	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	24'10"	72'10"
Length:	24'0"	24'0"



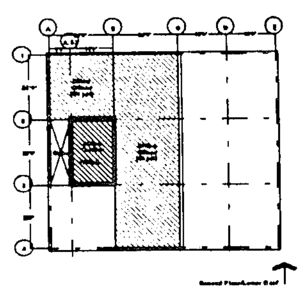
↓

Highlight: Corridor: Main 100 psf

↓

Assign Corridor: Main 100 psf

	Horizontal	Vertical
Base Point:	8'10"	24'10"
Point 2:	24'10"	48'10"
Length:	16'0"	24'0"



↓

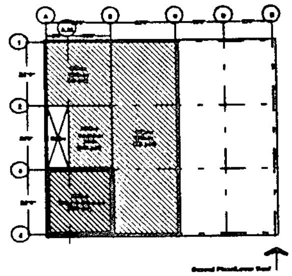
Highlight: Files & Storage 150 psf

↓

Assign Live Loads

Assign Files & Storage 150 psf

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	24'10"	24'10"
Length:	24'0"	24'0"



Stop Using Occupancy (LL)

Assign Dead Loads

Assign Floor Loads

Use Floor (DL)

Assign Second Floor Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	24'10"
Length:	48'0"	24'0"

Assign Second Floor Load

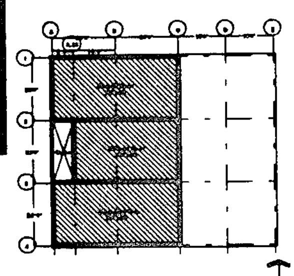
☐ Assign All Floors

	Horizontal	Vertical
Base Point:	8'10"	24'10"
Point 2:	48'10"	48'10"
Length:	40'0"	24'0"

Assign Second Floor Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	48'10"	72'10"
Length:	48'0"	24'0"



Stop Using Floor (DL)

Assign Dead Loads

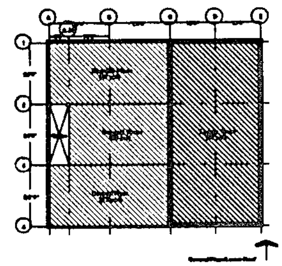
Assign Roof Loads

Use Roof (DL)

Assign Lower Roof Load

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	84'10"	72'10"
Length:	36'0"	72'0"

Select Lower Roof



Stop Using Roof (DL)

Assign Exterior Wall Loads

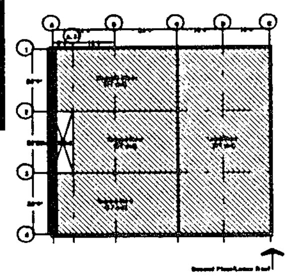
Use Wall (DL)

Assign Exterior Wall Load

☒ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	10"	72'10"
Length:	0'0"	72'0"

Select Exterior Wall



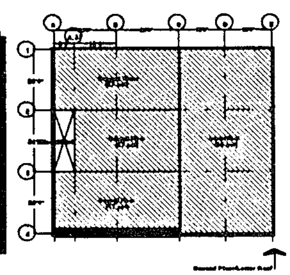
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	10"
Length:	48'0"	0'0"



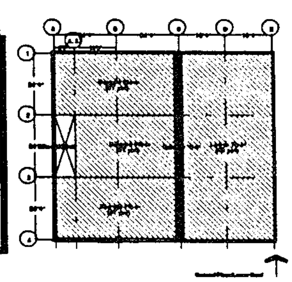
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	48'10"	72'10"
Length:	0'0"	72'0"



Assign Dead Loads

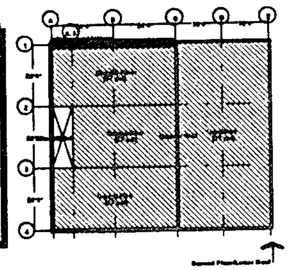
Assign Exterior Wall Loads

Wall Height
Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	72'10"
Point 2:	48'10"	72'10"
Length:	48'0"	0'0"



Wall Height
Start: 14'0"
End: 14'0"

Assign Parapet Wall Loads

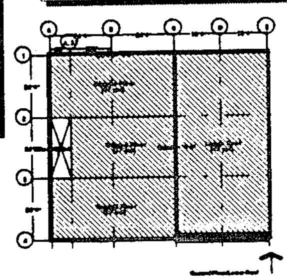
Use Wall (DL)

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	84'10"	10"
Length:	36'0"	0'0"

Select Parapet Wall

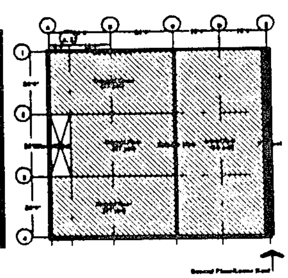


Wall Height
Start: 4'0"
End: 4'0"

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	10"
Point 2:	84'10"	72'10"
Length:	0'0"	72'0"



Wall Height
Start: 4'0"
End: 4'0"

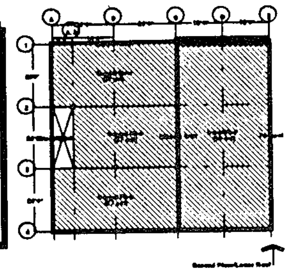
Assign Dead Loads

Assign Parapet Wall Loads

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	72'10"
Point 2:	84'10"	72'10"
Length:	36'0"	0'0"



Wall Height

Start: 4'0"
End: 4'0"

Stop Using Wall (DL)

Assign Upper Roof Loads

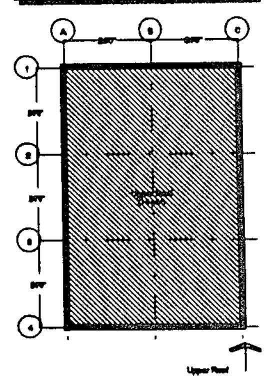
Select Upper Roof Horizontal Structural Plane

Use Roof (DL)

Assign Upper Roof Load

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	72'10"
Length:	48'0"	72'0"

Select Upper Roof



Stop Using Roof (DL)

Assign Ground Floor Wall Loads

Select Ground Floor Horizontal Structural Plane

Structural Plane Information

Name: Ground Floor

Assign Dead Loads

Assign Ground Floor Wall Loads

Close Structural Plane Information Dialog Window

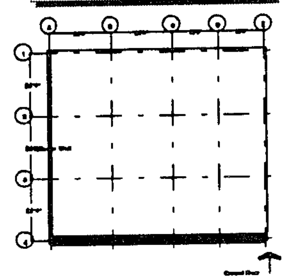
Use Wall (DL)

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	84'10"	10"
Length:	84'0"	0'0"

Select Exterior Wall



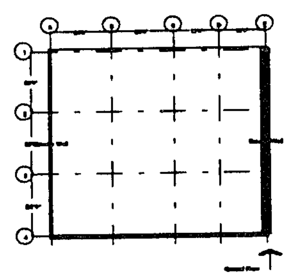
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	10"
Point 2:	84'10"	72'10"
Length:	0'0"	72'0"



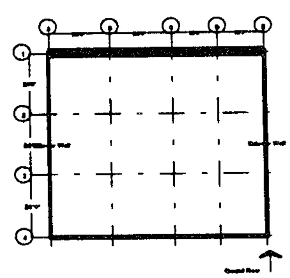
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

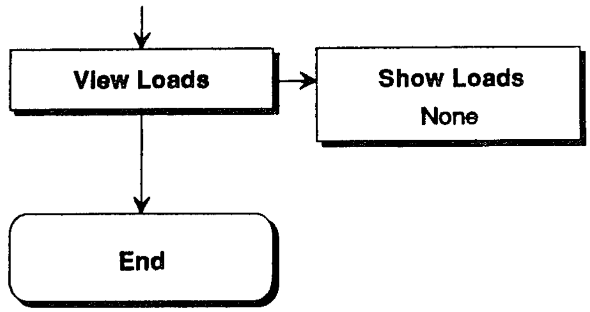
	Horizontal	Vertical
Base Point:	10"	72'10"
Point 2:	84'10"	72'10"
Length:	84'0"	0'0"

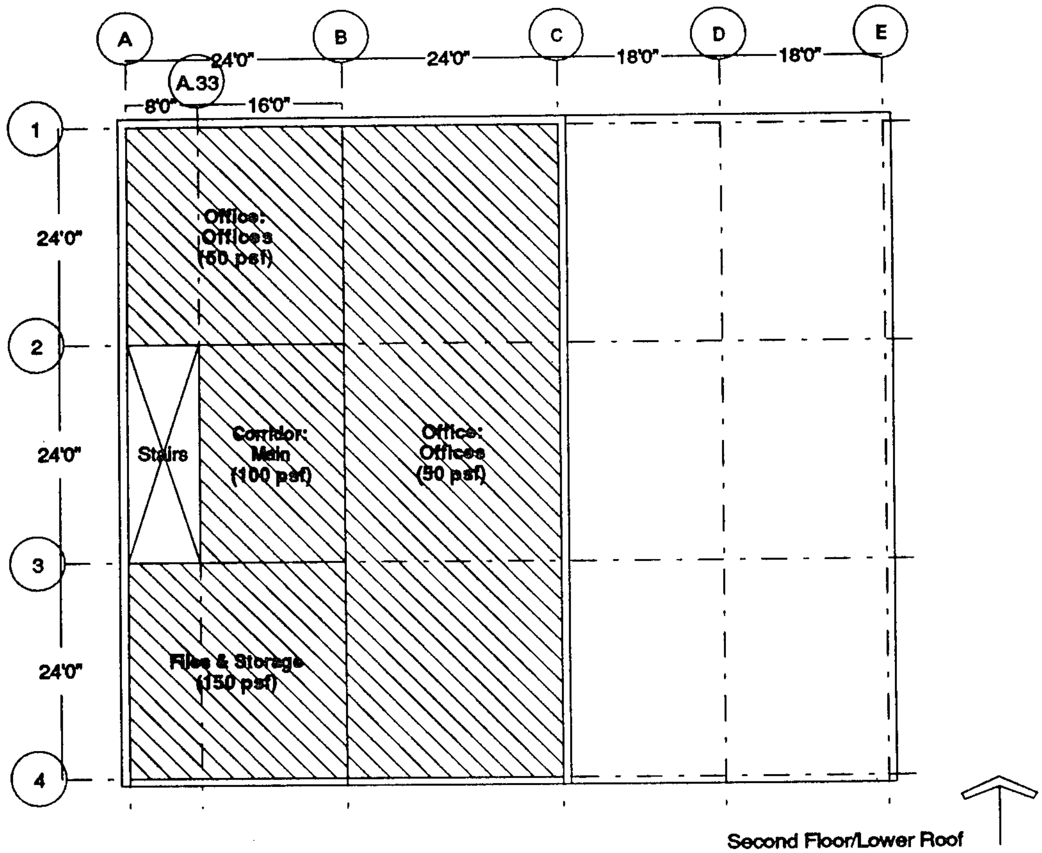


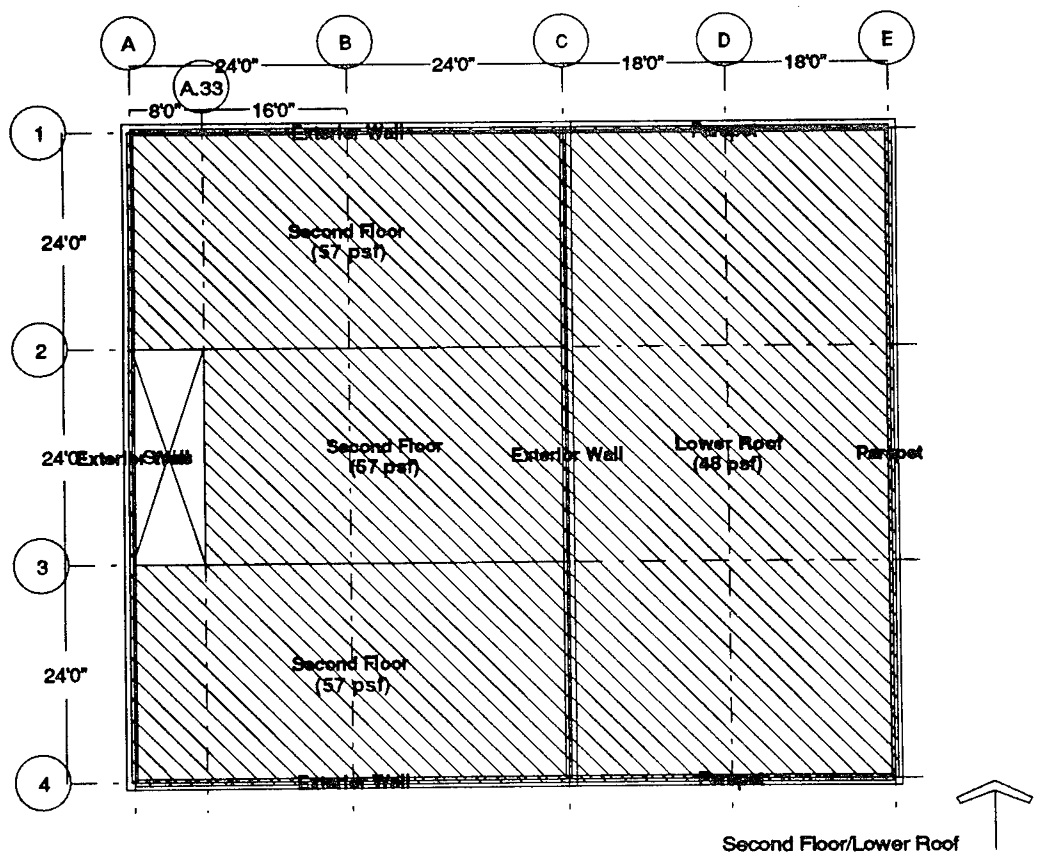
Wall Height

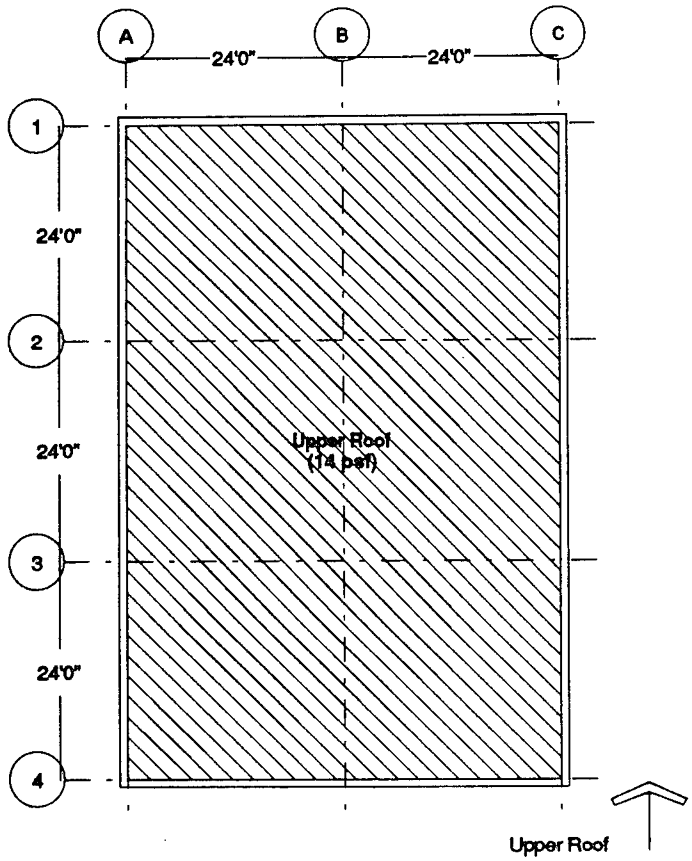
Start: 14'0"
End: 14'0"

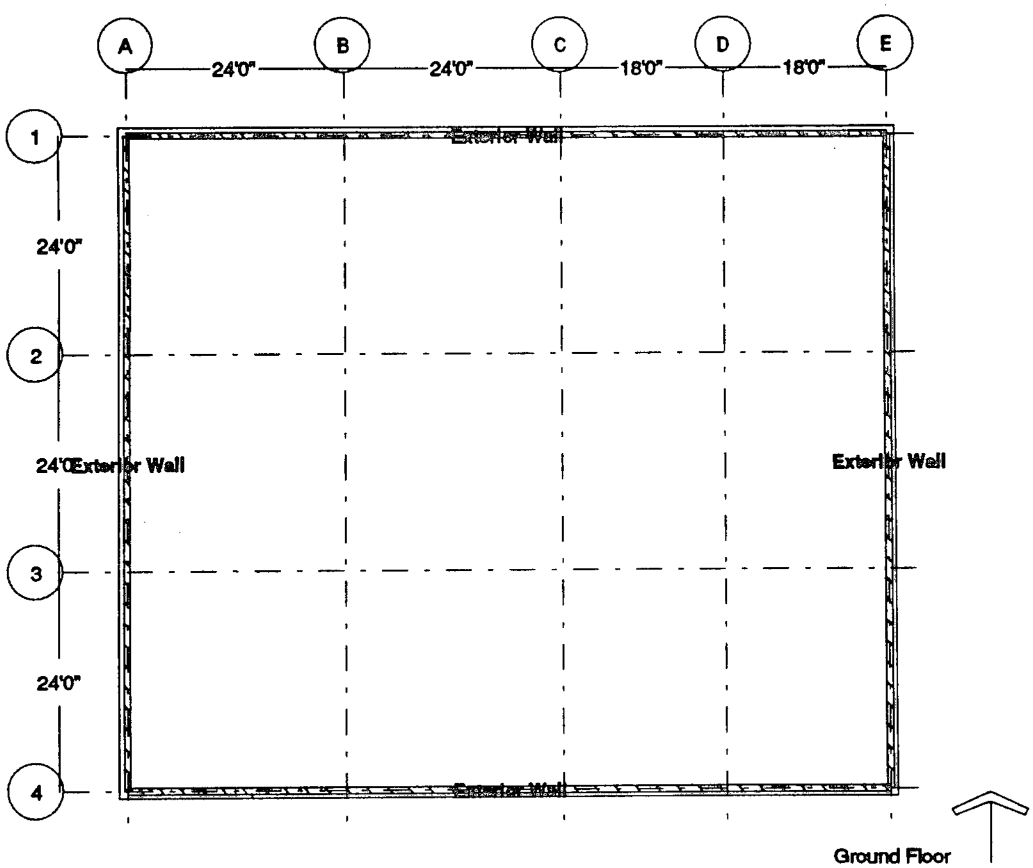
Stop Using Wall (DL)


View Loads
Show Loads
None
End


A
B
C
D
E
24'0"
24'0"
18'0"
18'0"
A.33
8'0"
16'0"
1
2
3
4
24'0"
24'0"
24'0"
Office:
Offices
(50 psf)
Stairs
Corridor:
Main
(100 psf)
Office:
Offices
(50 psf)
Files & Storage
(150 psf)
Second Floor/Lower Roof


A
B
C
D
E
24'0"
24'0"
18'0"
18'0"
A.33
8'0"
16'0"
1
2
3
4
24'0"
24'0"
24'0"
Exterior Wall
Parapet
Second Floor
(57 psf)
Exterior Wall
Second Floor
(57 psf)
Exterior Wall
Lower Roof
(48 psf)
Parapet
Second Floor
(57 psf)
Exterior Wall
Parapet
Second Floor/Lower Roof

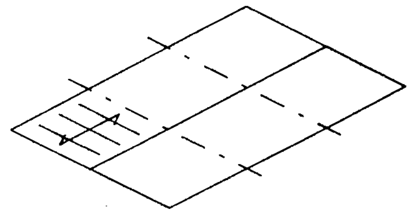

A
B
C
24'0"
24'0"
1
2
3
4
24'0"
24'0"
24'0"
Upper Roof
(14 psf)
Upper Roof


A
B
C
D
E
24'0"
24'0"
18'0"
18'0"
1
2
3
4
24'0"
24'0"
24'0"
Exterior Wall
Exterior Wall
Exterior Wall
Exterior Wall
Ground Floor

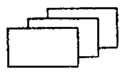
Analysis & Design Philosophy

Preliminary Analysis

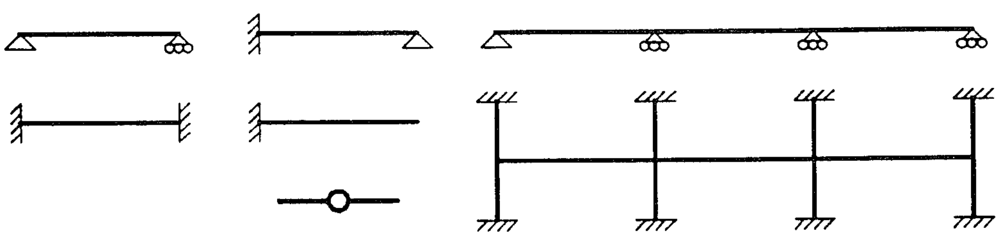
A. Select: * Material
* Load Combination
    (Live Load Reduction)
* Element To Analyze



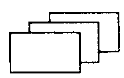
B. Review: * Attributes
* Guidelines



C. Connectivity

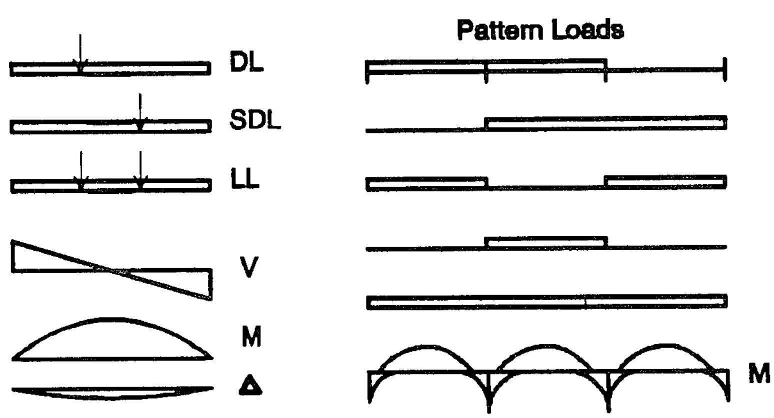


D. Self Weight Estimate * Guidelines



E. Analysis * Review Loads
* Connectivity

* Analysis Output
I = 1
E = 1
A = 1000

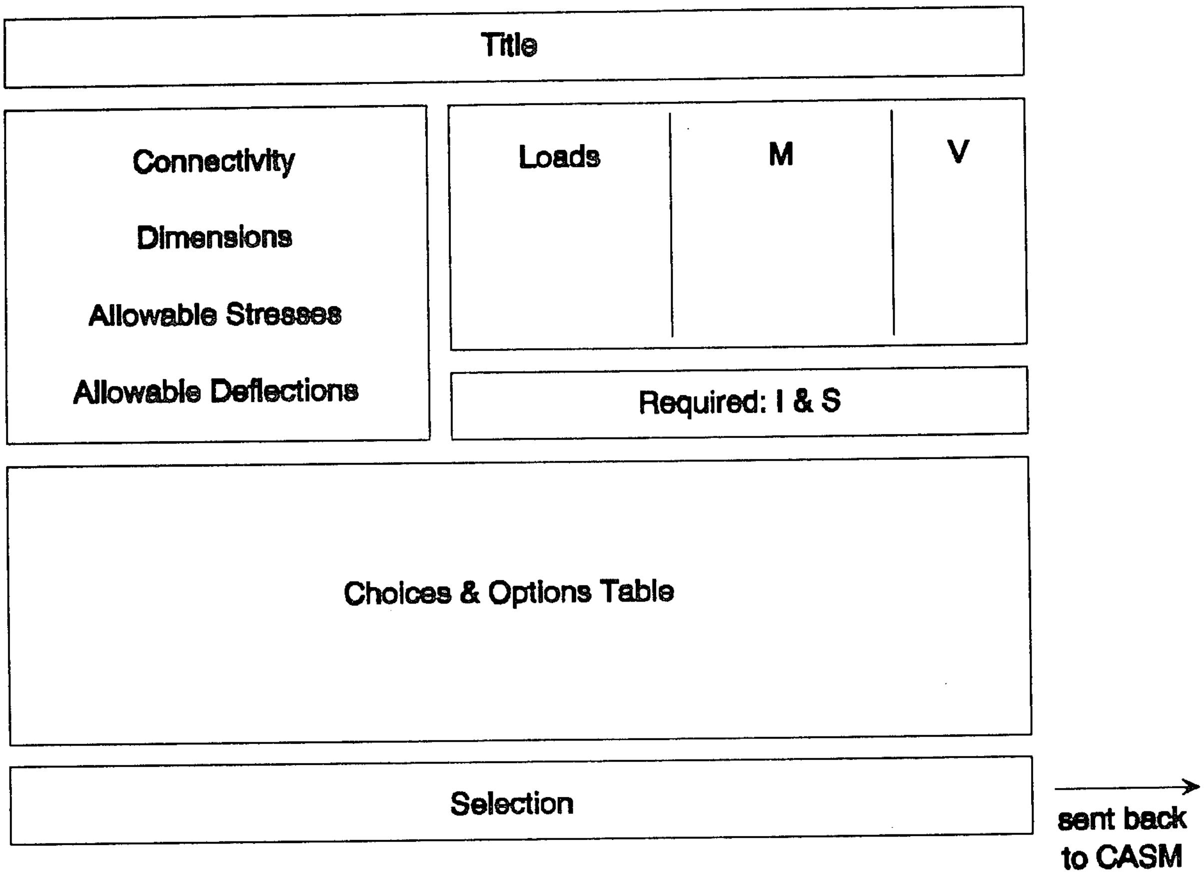


F. Re-Analysis (with real properties)

Preliminary Design

* Maximum V's, M's, R's, etc. sent to Excel

Spreadsheets



Surface Element Analysis

Start

Use Loads & Design Tool Palette

Select Upper Roof Horizontal Structural Plane

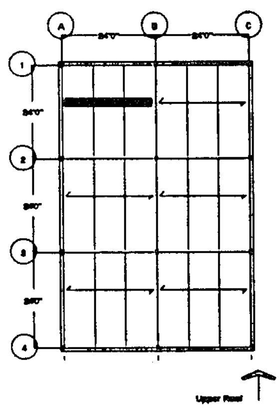
Material Steel

Select Element To Analyze & Design

Surface One-Way Roof Deck

Select A One-Way Surface Element

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads

Use Compare Min. Roof LL & Snow Loads

Analysis

Units: Feet & Pounds

Decking Analysis

Number Of Spans: 3

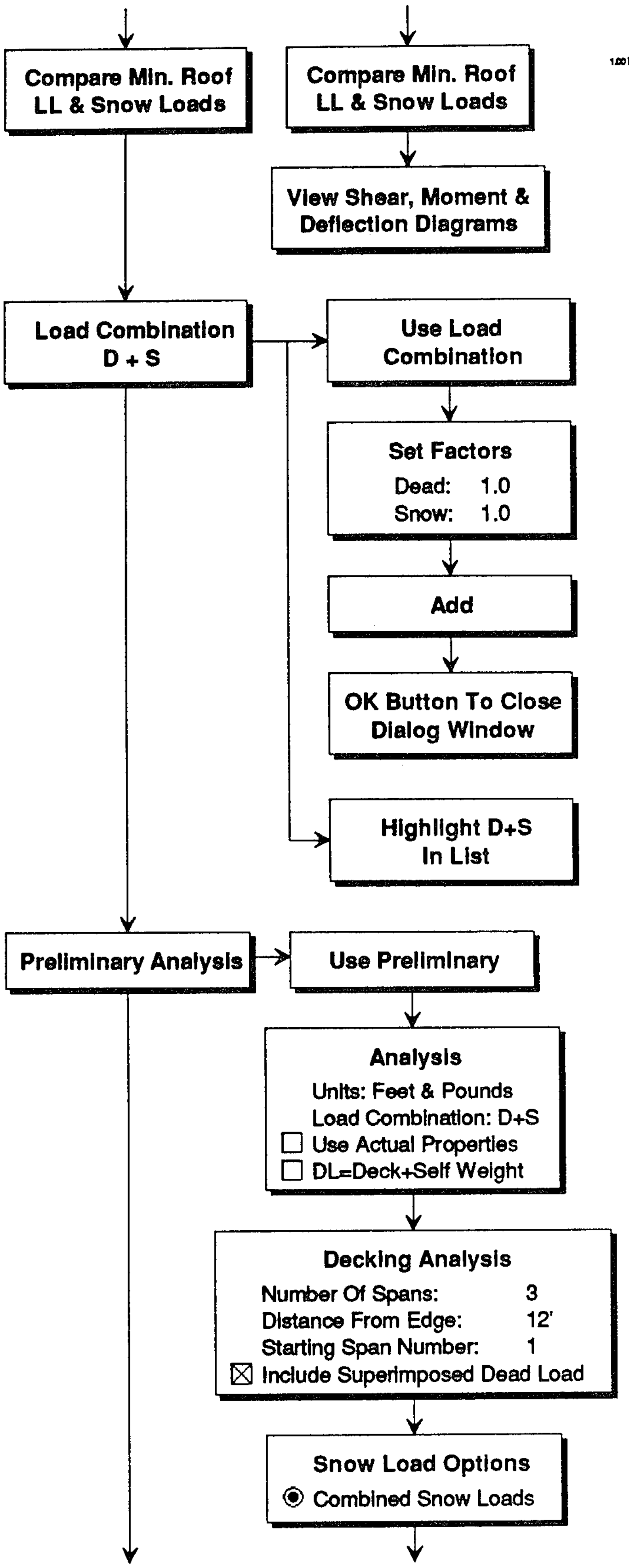
Distance From Edge: 12'

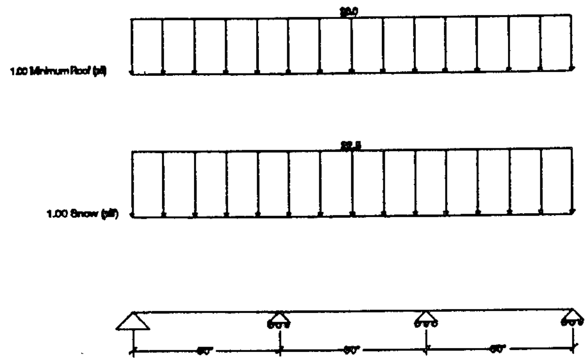
Starting Span Number: 1

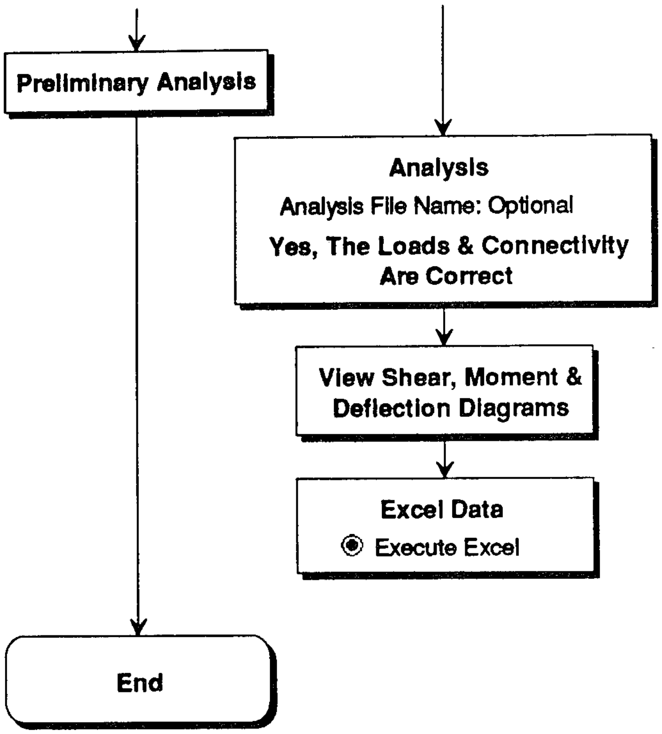
Snow Load Options

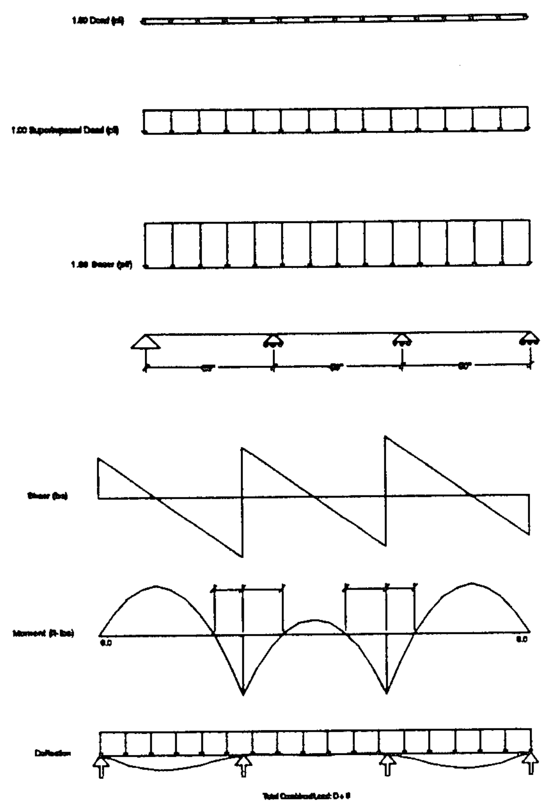
◉ Combined Snow Loads

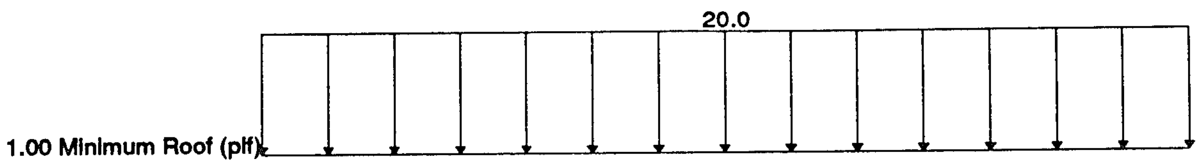
Minimum Roof (LL)

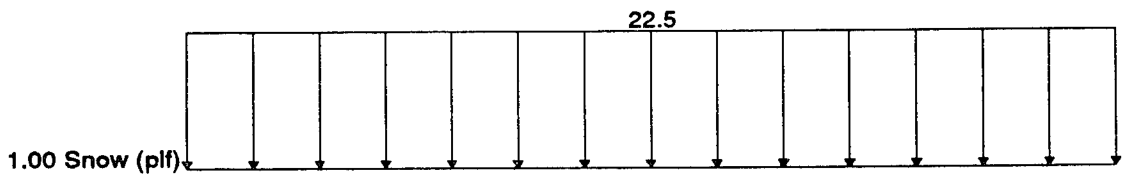

Compare Min. Roof LL & Snow Loads
Compare Min. Roof LL & Snow Loads
View Shear, Moment & Deflection Diagrams
Load Combination D + S
Use Load Combination
Set Factors
Dead: 1.0
Snow: 1.0
Add
OK Button To Close Dialog Window
Highlight D+S In List
Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: D+S
☐ Use Actual Properties
☐ DL=Deck+Self Weight
Decking Analysis
Number Of Spans: 3
Distance From Edge: 12'
Starting Span Number: 1
☒ Include Superimposed Dead Load
Snow Load Options
◉ Combined Snow Loads

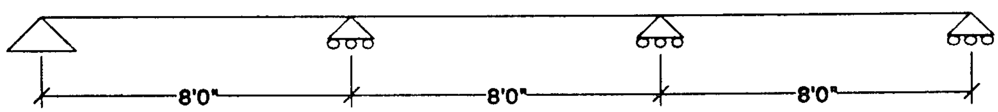

1.00 Minimum Roof (plf)
1.00 Snow (plf)


Preliminary Analysis
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End

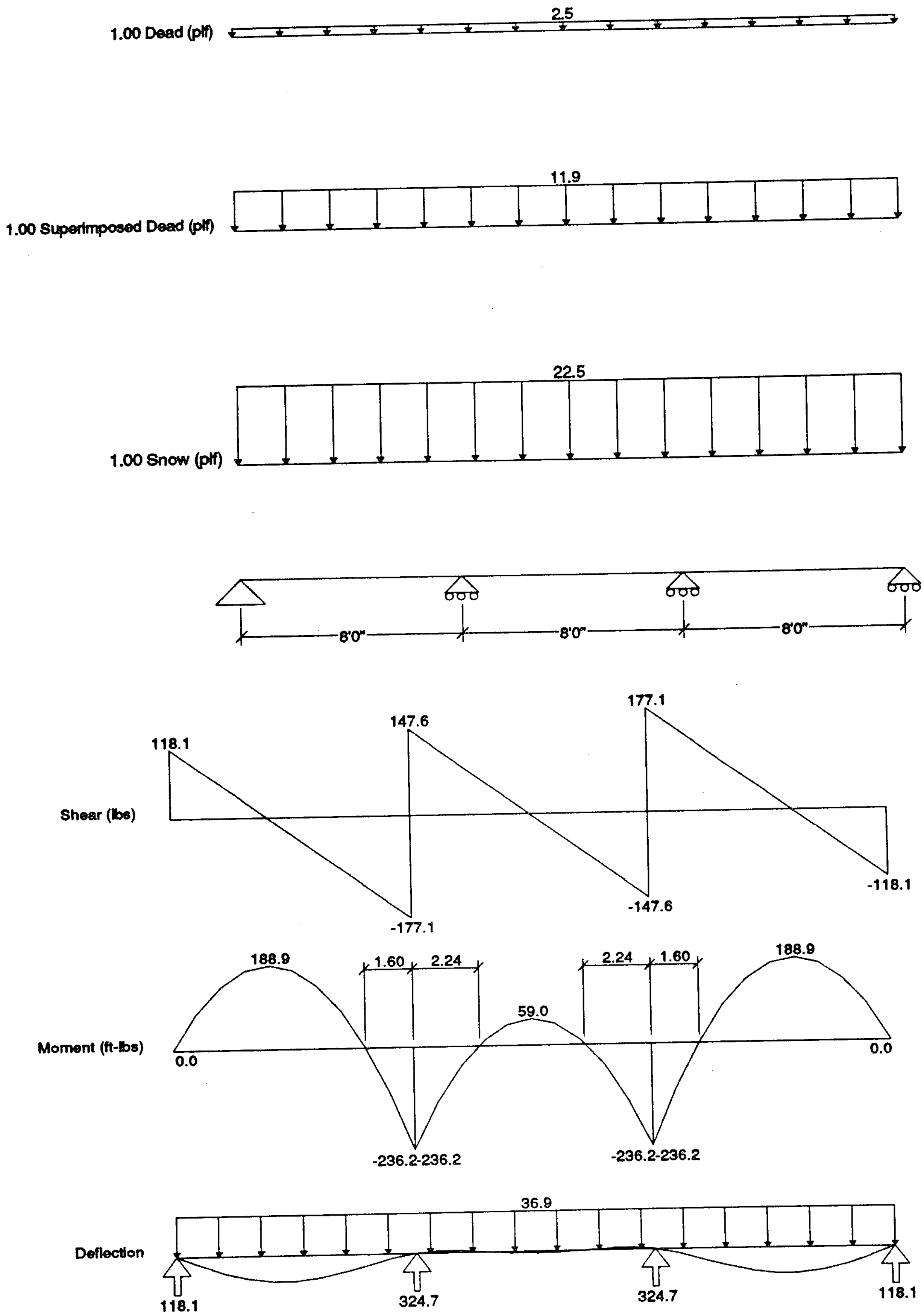






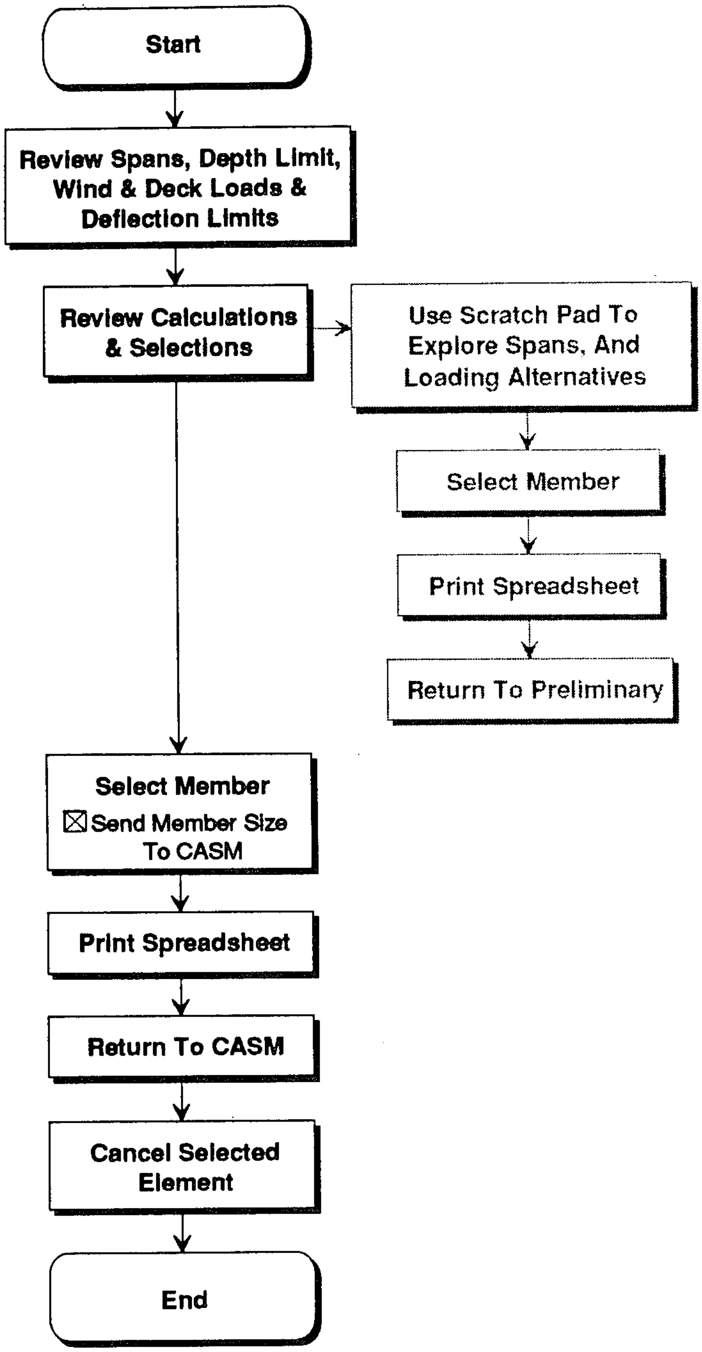



```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Tue Aug 30, 1994  12:08 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 24.0 sqft
Roof Slope     (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200        R1 = 1.00
F <= 4           R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 20.00 psf     |
+------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```



Total Combined Load: D + S

Steel Roof Deck Design



STEEL ROOF DECK PRELIMINARY SELECTION

Project: Office Building - Scheme A	**Date:** Aug 30, 1994
Location: Radford AAP	**Engr:**

Load and Analysis Data:

Method: Analysis
Member ID:
Connectivity: Beam (Left)
Beam (Right)
Deck Span: 8 ft
Trib Width= 12 in
Depth Limit= **1.5** in. max
Fy= 33.0 ksi
Fb= 20.0 ksi
Fv= 13.2 ksi
E = 29,000 ksi
Live Ld Defl= **L/240** =0.40 in
Total Defl= **L/180** =0.53 in

Load Combination: D + S

Load Type	Factored Moments (lb-ft) Left	Mid	Right	Fact. Reactions Left(lb)	Right(lb)
Deck	16.0	12.8	16.0	12.0	12.0
Sup Dead	76.2	60.9	76.2	57.1	57.1
Live					
Lmin Roof					
Snow	144.0	115.2	144.0	108.0	108.0
Wind					
Summary	236.2	188.9	236.2	177.1	177.1

Load Combinations for roof:

Load Case #1:	D + S	Est. Deck Wgt = **2.0 psf**
Load Case #2:	Deck + Wind	Wind Load = **-30.0 psf**
Load Case #3:	Deck + Construction 200# Point Load	

Deck Configuration:

Deck Type: Roof Deck

Code Load Combinations:

	Case	Load (psf)	Fb Factor	M+ (f-lb)	M- (f-lb)	S+ (in.3)	S- (in.3)	Ix (in.4)
Number of spans = 3	# 1		1.00	188.9	92.2	0.113	0.055	0.1531
	# 2	-28.0	1.33	209.7	-168.4	0.095	-0.076	0.1263
	# 3	2.0	1.33	332.0	-183.0	0.150	-0.083	0.1716
Maximums:				332.0	-183.0	**0.150**	**-0.083**	**0.1716**

Steel Roof Deck Selection Table - Spans = 3

Deck Type	Gage	Depth (in)	Sx+ (in.^3)	Sx- (in.^3)	Ix (in.^4)	Dk wgt (psf)	Const Span Limit 1 Span	2+Span
WR 20	20	1.5	0.232	-0.245	0.210	2.1	6'-3"	7'-5"
IR18	18	1.5	0.189	-0.194	0.206	2.7	6'-2"	7'-4"
WR18	18	1.5	0.316	-0.325	0.290	2.8	7'-6"	8'-10"
NR18	18	1.5	0.163	-0.168	0.188	2.8	5'-11"	6'-11"

CASM Preliminary Steel Roof Deck Selection:

Deck Type: **WR 20**	Span= 8.0 ft	Depth: 1.5 in	Description: 2-1/2"Rib@6"oc	
Weight: 2.1 psf	Gage: 20	Ix = 0.21	Construction Load Span Limits:	
	Sx+ = 0.232	Sx- = -0.245	1 span: 6'-3"	2+span: 7'-5"

Notes:

1. Steel roof deck properties from representative manufacturer's data.
2. Design calculations from SDI Design Manual for Roof Deck - 1987.

Narrowly Spaced Element Analysis

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

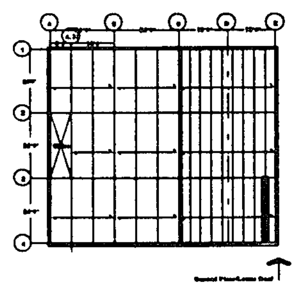
Material Steel

Select Element To Analyze & Design

Linear Narrowly Spaced Open-Web Joists-K

Select A Narrowly Spaced Element Near A Corner

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads

Use Compare Min. Roof LL & Snow Loads

Analysis

Units: Feet & Pounds

Connectivity

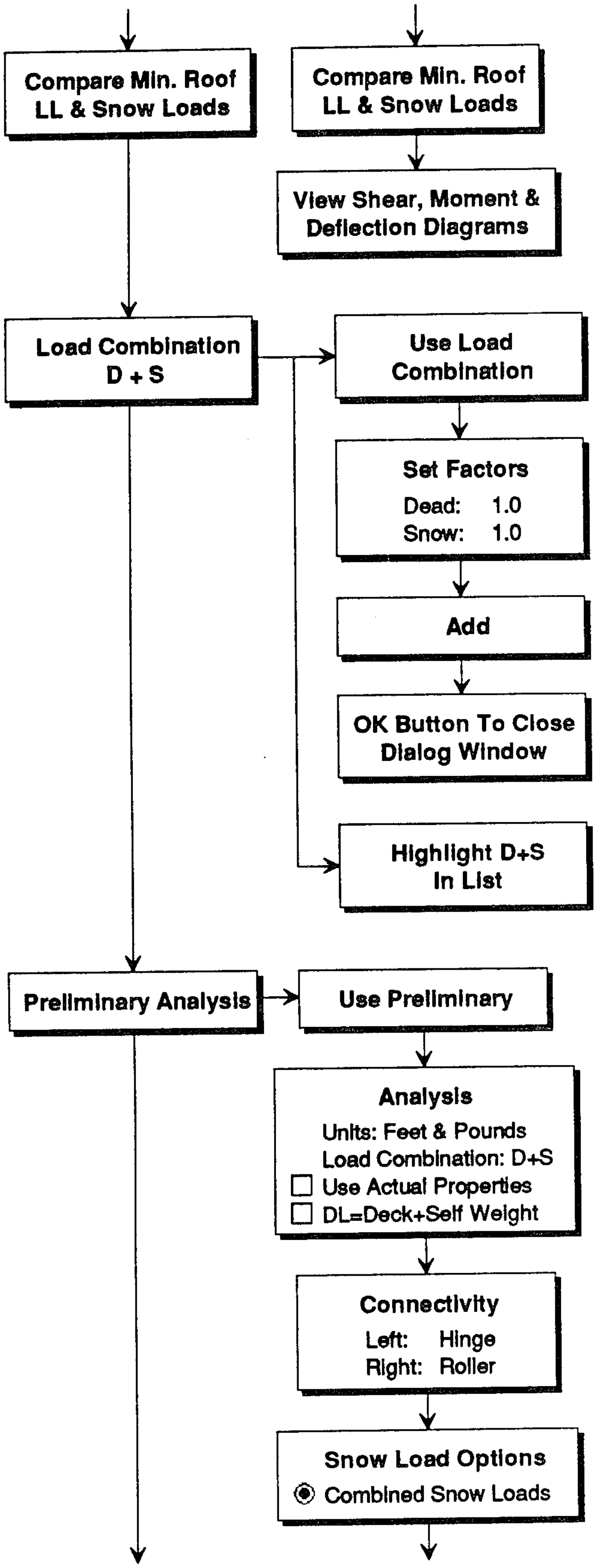
Left: Hinge

Right: Roller

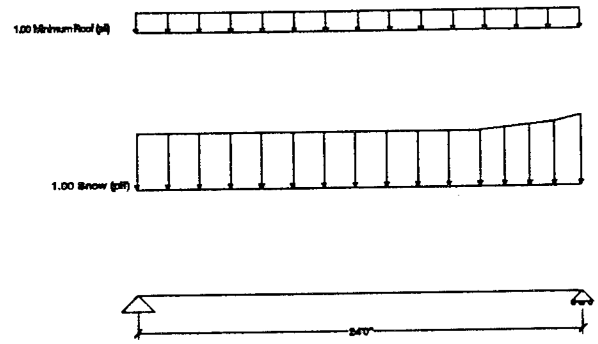
Snow Load Options

◉ Combined Snow Loads

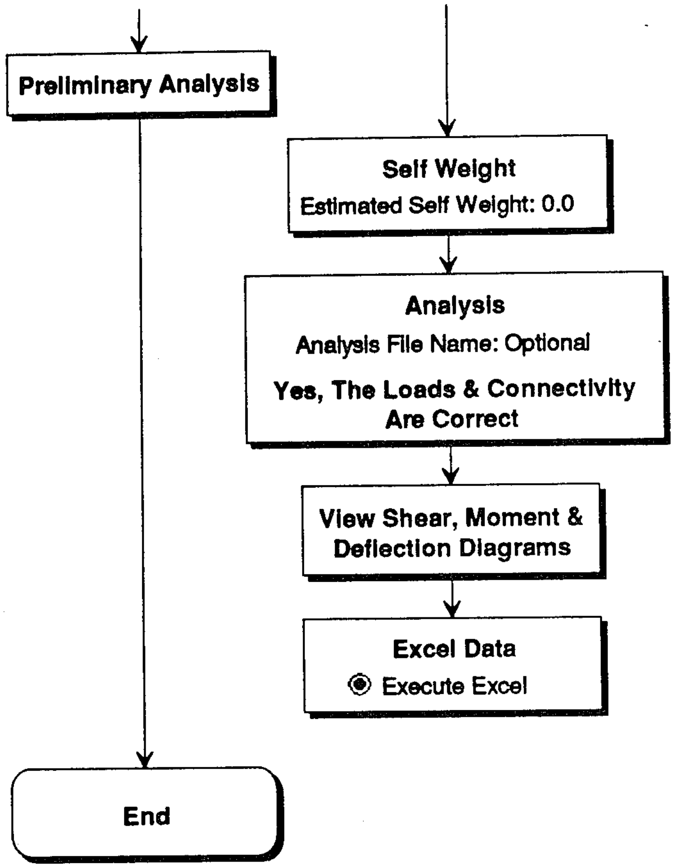
Minimum Roof (LL)

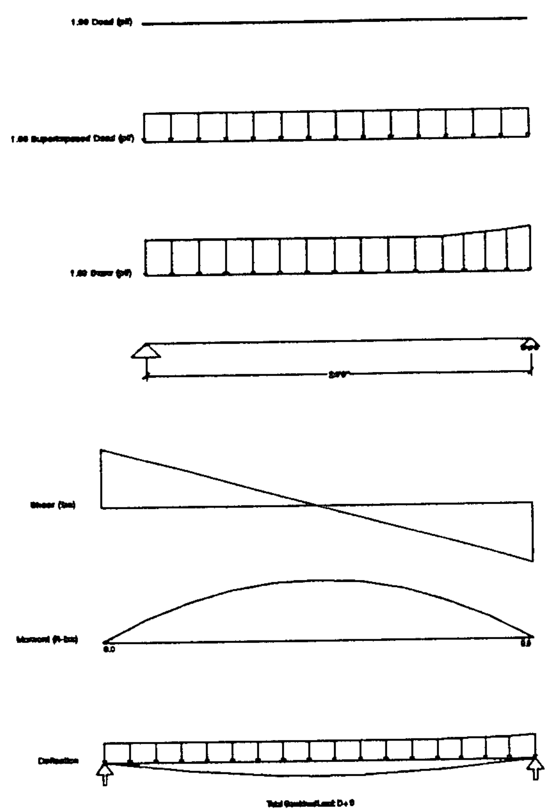


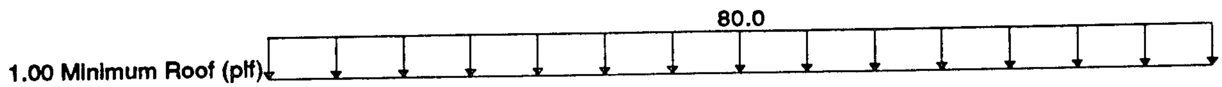
Compare Min. Roof LL & Snow Loads
Compare Min. Roof LL & Snow Loads
View Shear, Moment & Deflection Diagrams
Load Combination D + S
Use Load Combination
Set Factors
Dead: 1.0
Snow: 1.0
Add
OK Button To Close Dialog Window
Highlight D+S In List
Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: D+S
☐ Use Actual Properties
☐ DL=Deck+Self Weight
Connectivity
Left: Hinge
Right: Roller
Snow Load Options
◉ Combined Snow Loads

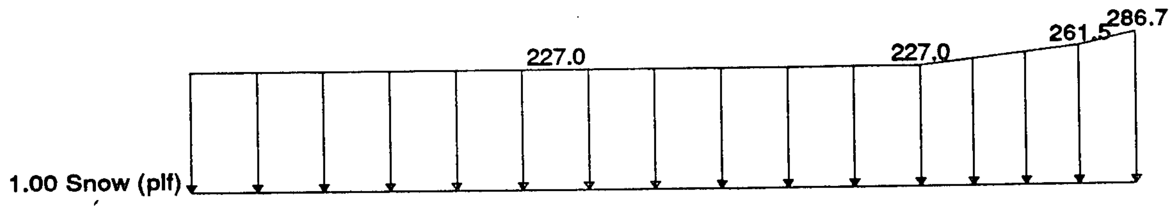


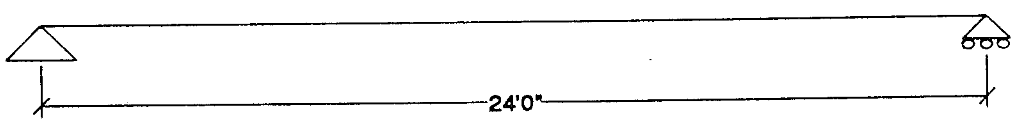
1.00 Minimum Roof (plf)
1.00 Snow (plf)


Preliminary Analysis
Self Weight
Estimated Self Weight: 0.0
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End

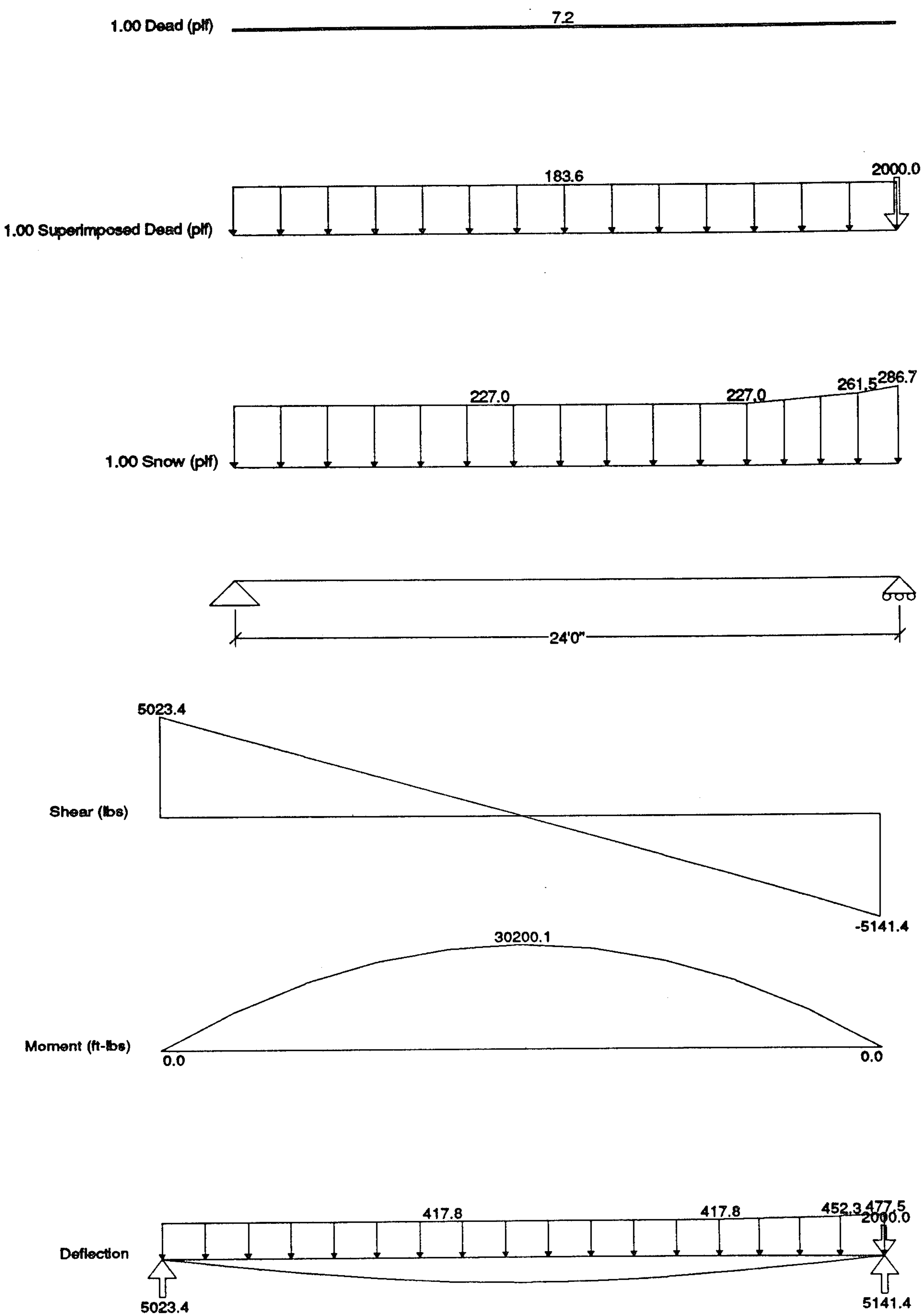









```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Tue Aug 30, 1994  2:44 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At)  : 96.0 sqft
Roof Slope      (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200         R1 = 1.00
F <= 4            R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+-------------------------+
|     Lr = 20.00 psf      |
+-------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```



Total Combined Load: D + S

```
*******************************************
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
*******************************************
```

2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

********************************* I N P U T *********************************

Office Building - Scheme A -- 1.00 Dead Load

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	1

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-7.20	0.00		2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	8.640	3.456	0.000	8.640	-3.456

JOINT DATA

UNITS: FEET, POUNDS

				BOUNDARY CONDITIONS			
		NODAL COORDINATES		NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	1	4.00	4.00	0.50
9	9	10	1	1	0	1	4.00	4.00	0.50
10	10	11	1	1	0	1	4.00	4.00	0.50

********************************* O U T P U T *********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-597.1968
2	0.0000	-16872.4818	-563.7538
3	0.0000	-31921.8411	-472.9799
4	0.0000	-43703.3396	-339.2078
5	0.0000	-51185.0211	-176.7703
6	0.0000	-53747.7120	0.0000
7	0.0000	-51185.0211	176.7703
8	0.0000	-43703.3396	339.2078
9	0.0000	-31921.8411	472.9799
10	0.0000	-16872.4818	563.7538
11	0.0000	0.0000	597.1968

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	86.400	0.000	0.000	-69.120	186.624
2	0.000	69.120	-186.624	0.000	-51.840	331.776
3	0.000	51.840	-331.776	0.000	-34.560	435.456
4	0.000	34.560	-435.456	0.000	-17.280	497.664
5	0.000	17.280	-497.664	0.000	0.000	518.400
6	0.000	0.000	-518.400	0.000	17.280	497.664
7	0.000	-17.280	-497.664	0.000	34.560	435.456
8	0.000	-34.560	-435.456	0.000	51.840	331.776
9	0.000	-51.840	-331.776	0.000	69.120	186.624
10	0.000	-69.120	-186.624	0.000	86.400	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	86.400	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	86.400	0.000

PROBLEMS COMPLETED

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*******************************************
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
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2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

********************************* I N P U T *********************************

Office Building - Scheme A -- 1.00 Superimposed Dead Load

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	1

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-183.60	0.00		2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	220.320	88.128	0.000	220.320	-88.128

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	1	4.00	4.00	0.50
9	9	10	1	1	0	1	4.00	4.00	0.50
10	10	11	1	1	0	1	4.00	4.00	0.50

******************************** O U T P U T ********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-15228.5184
2	0.0000	-430248.2847	-14375.7214
3	0.0000	-814006.9483	-12060.9866
4	0.0000	-1114435.1593	-8649.7985
5	0.0000	-1305218.0378	-4507.6414
6	0.0000	-1370566.6560	0.0000
7	0.0000	-1305218.0378	4507.6414
8	0.0000	-1114435.1593	8649.7985
9	0.0000	-814006.9483	12060.9866
10	0.0000	-430248.2847	14375.7214
11	0.0000	0.0000	15228.5184

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	2203.200	0.000	0.000	-1762.560	4758.912
2	0.000	1762.560	-4758.912	0.000	-1321.920	8460.288
3	0.000	1321.920	-8460.288	0.000	-881.280	11104.128
4	0.000	881.280	-11104.128	0.000	-440.640	12690.432
5	0.000	440.640	-12690.432	0.000	0.000	13219.200
6	0.000	0.000	-13219.200	0.000	440.640	12690.432
7	0.000	-440.640	-12690.432	0.000	881.280	11104.128
8	0.000	-881.280	-11104.128	0.000	1321.920	8460.288
9	0.000	-1321.920	-8460.288	0.000	1762.560	4758.912
10	0.000	-1762.560	-4758.912	0.000	2203.200	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	2203.200	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	2203.200	0.000

PROBLEMS COMPLETED

****
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

********************************* I N P U T *********************************

Office Building - Scheme A -- 1.00 Snow Load

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	4

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-226.99	0.00		2.40
2	UNIFRM	2.40	-226.99	0.00		1.74
2	RAMP	2.40	-226.99	1.74	-232.69	2.40
3	RAMP	2.40	-232.69	0.00	-253.40	2.40
4	RAMP	2.40	-253.40	0.00	-261.49	0.94
4	RAMP	2.40	-261.49	0.94	-286.72	2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	272.386	108.954	0.000	272.386	-108.954
2	0.000	272.450	109.002	0.000	274.208	-109.265
3	0.000	286.687	115.669	0.000	296.627	-117.657
4	0.000	312.831	126.477	0.000	329.404	-129.853

JOINT DATA

UNITS: FEET, POUNDS

				BOUNDARY CONDITIONS			
		NODAL COORDINATES		NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	2	4.00	4.00	0.50
9	9	10	1	1	0	3	4.00	4.00	0.50
10	10	11	1	1	0	4	4.00	4.00	0.50

******************************** O U T P U T ********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-18962.7216
2	0.0000	-535784.4750	-17904.2668
3	0.0000	-1013855.3129	-15030.1394
4	0.0000	-1388427.8640	-10792.1951
5	0.0000	-1626730.9187	-5642.2892
6	0.0000	-1709006.7080	-32.2776
7	0.0000	-1628510.9034	5585.9844
8	0.0000	-1391512.6167	10760.6411
9	0.0000	-1017294.4159	15039.8270
10	0.0000	-538185.6478	17967.1701
11	0.0000	0.0000	19058.1368

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	2733.806	0.000	0.000	-2189.034	5907.408
2	0.000	2189.034	-5907.408	0.000	-1644.262	10507.364
3	0.000	1644.262	-10507.364	0.000	-1099.491	13799.868
4	0.000	1099.491	-13799.868	0.000	-554.719	15784.919
5	0.000	554.719	-15784.919	0.000	-9.947	16462.518
6	0.000	9.947	-16462.518	0.000	534.825	15832.664
7	0.000	-534.825	-15832.664	0.000	1079.597	13895.357
8	0.000	-1079.597	-13895.357	0.000	1626.255	10650.183
9	0.000	-1626.255	-10650.183	0.000	2209.569	6057.134
10	0.000	-2209.569	-6057.134	0.000	2851.803	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
.1	0.000	2733.806	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	2851.803	0.000

PROBLEMS COMPLETED

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*******************************************
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
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2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

******************************** I N P U T ********************************

Office Building - Scheme A -- Total Combined Load: D + S

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	4

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-417.79	0.00		2.40
2	UNIFRM	2.40	-190.80	0.00		2.40
2	UNIFRM	2.40	-226.99	0.00		1.74
2	RAMP	2.40	-226.99	1.74	-232.69	2.40
3	UNIFRM	2.40	-190.80	0.00		2.40
3	RAMP	2.40	-232.69	0.00	-253.40	2.40
4	UNIFRM	2.40	-190.80	0.00		2.40
4	RAMP	2.40	-253.40	0.00	-261.49	0.94
4	RAMP	2.40	-261.49	0.94	-286.72	2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	501.346	200.538	0.000	501.346	-200.538
2	0.000	501.410	200.586	0.000	503.168	-200.849
3	0.000	515.647	207.253	0.000	525.587	-209.241
4	0.000	541.791	218.061	0.000	556.364	-221.437

JOINT DATA

UNITS: FEET, POUNDS

				BOUNDARY CONDITIONS			
		NODAL COORDINATES		NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	2	4.00	4.00	0.50
9	9	10	1	1	0	3	4.00	4.00	0.50
10	10	11	1	1	0	4	4.00	4.00	0.50

********************************* O U T P U T *********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-34788.4368
2	0.0000	-982905.2414	-32843.7420
3	0.0000	-1859784.1024	-27564.1059
4	0.0000	-2546566.3629	-19781.2013
5	0.0000	-2983133.9776	-10326.7009
6	0.0000	-3133321.0760	-32.2776
7	0.0000	-2984913.9624	10270.3961
8	0.0000	-2549651.1156	19749.6473
9	0.0000	-1863223.2053	27573.7935
10	0.0000	-985306.4142	32906.6452
11	0.0000	0.0000	34883.8520

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	5023.406	0.000	0.000	-4020.714	10852.944
2	0.000	4020.714	-10852.944	0.000	-3018.022	19299.428
3	0.000	3018.022	-19299.428	0.000	-2015.331	25339.452
4	0.000	2015.331	-25339.452	0.000	-1012.639	28973.015
5	0.000	1012.639	-28973.015	0.000	-9.947	30200.118
6	0.000	9.947	-30200.118	0.000	992.745	29020.760
7	0.000	-992.745	-29020.760	0.000	1995.437	25434.941
8	0.000	-1995.437	-25434.941	0.000	3000.015	19442.247
9	0.000	-3000.015	-19442.247	0.000	4041.249	11002.670
10	0.000	-4041.249	-11002.670	0.000	5141.403	0.000

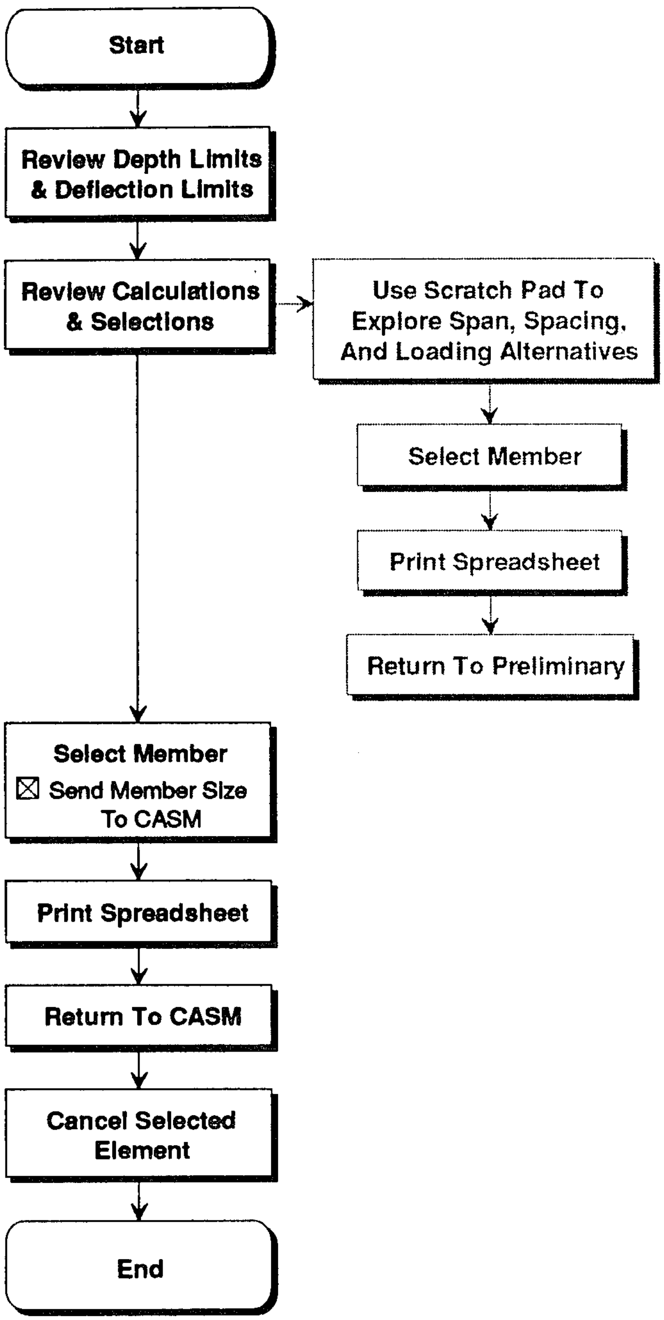
APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	5023.406	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	5141.403	0.000

PROBLEMS COMPLETED

Steel Open-Web Joist Design



STEEL BAR JOIST PRELIMINARY SELECTION

Project: Office Building - Scheme A	**Date:** Aug 31, 1994
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis
Member ID:
Connection: Hinge (Left) Roller (Right)
Span: 24.0 ft
Spacing: 48.0 in
Depth Limit= **30.0** in. max
Fy= 50.0 ksi
Fb= 30.0 ksi
E = 29,000 ksi
Live Defl= **L/360=** 0.80 in
Total Defl= **L/240=** 1.20 in

Load Combination D + S

LoadType	Factored Moment (ft-lb) Left	Mid	Right	Factored Reaction Left(lb)	Right(lb)
Dead		518		86	86
Sup Dead		13,219		2,203	2,203
Live					
Lmin Roof					
Snow		16,463		2,734	2,852
Wind					
Summary		30,200		5,023	5,141

Moment EUL:	Total Ld= 419 plf Live Ld= 229 plf	Reaction EUL:	Total Ld= 428 plf Live Ld= 238 plf

Ponding Check: NO

CASM Joist Selection Table: (joist capacities)

Joist Size	Spacing (in)	Total Ld(plf)	Live Ld(plf)	Mmax (ftlb)	Rmax (lb)	Live Ld Defl(in)	Total Ld Defl(in)	Ponding	Jst Wgt (plf)
20K4	48.0	430	353	30,960	5,160	0.54	0.98		7.6
18K5	48.0	434	318	31,248	5,208	0.61	1.10		7.7
22K4	48.0	475	431	34,200	5,700	0.45	0.81		8.0
20K5	48.0	485	396	34,920	5,820	0.49	0.88		8.2

CASM Bar Joist Selection:

Joist Size: **20K4**	Span: 24.0 ft	Spacing: 48 in	TL defl: 0.98 in	LL defl: 0.54 in
Wgt(tons): 0.09	Mmax: 30,960	Rmax: 5,160	Total Ld: 430 plf	Live Ld: 353 plf

NOTES:

1. Bar joist selections based on 1993 SJI Load Tables.
   Edit spreadsheet stajstk.xls to revise selection table.
2. Approximate moment of inertia of the joist in inches^4 is:
   Ij = 26.767 (WLL) (L^3) (10^-6), where WLL = Live Load value in table;
   where L = Span - 0.33 in feet
3. Ponding check based on SJI Technical Digest. Refer to AISC Commentary section K2 for charts for Stress Constant U and Flexibility Constant C for joists bearing on beams.
   a. For joists bearing on steel beams, Cs must be greater than Csreq. This is not an automatic selection. Beam size and/or joist size may need to be increased.
   b. For joists bearing on walls, the ponding load includes dead load plus percentage of live load, plus computed ponding load. Selection is based on greatest load.

Widely Spaced Element Analysis: Beam

Start

↓

Use Loads & Design Tool Palette

↓

Select Second Floor/ Lower Roof Horizontal Structural Plane

↓

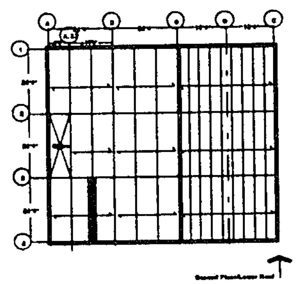
Material Steel

↓

Select Element To Analyze & Design → Linear Widely Spaced Rolled Section

↓ Select A Widely Spaced Element In Bay A3-B4

↓ Review Element Attributes & Guidelines



↓

Load Combination D + L → Use Load Combination

↓ Set Factors

Dead: 1.0

Live: 1.0

↓ Add

↓ OK Button To Close Dialog Window

→ Highlight D+L In List

↓

Preliminary Analysis

Use Preliminary

Analysis
Units: Feet & Pounds
Load Combination: D+L
☐ Apply Live Load Reduction
☐ Pattern Occupancy Live Load
☐ Use Actual Properties
☐ DL=Deck+Self Weight

Connectivity
Left: Hinge
Right: Roller

Self Weight

Guidelines

Find Estimate For 24' Span & 1.65 klf

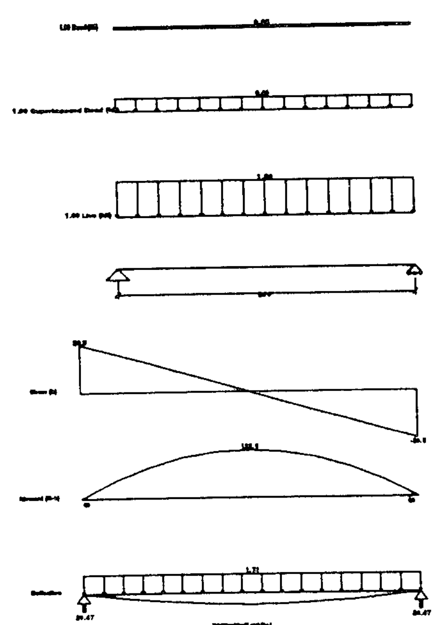
Close Self Weight Guidelines Dialog Window

Self Weight
Estimated Self Weight: 50 plf
☒ Update Area Structure Loads
☒ Add Self Weight

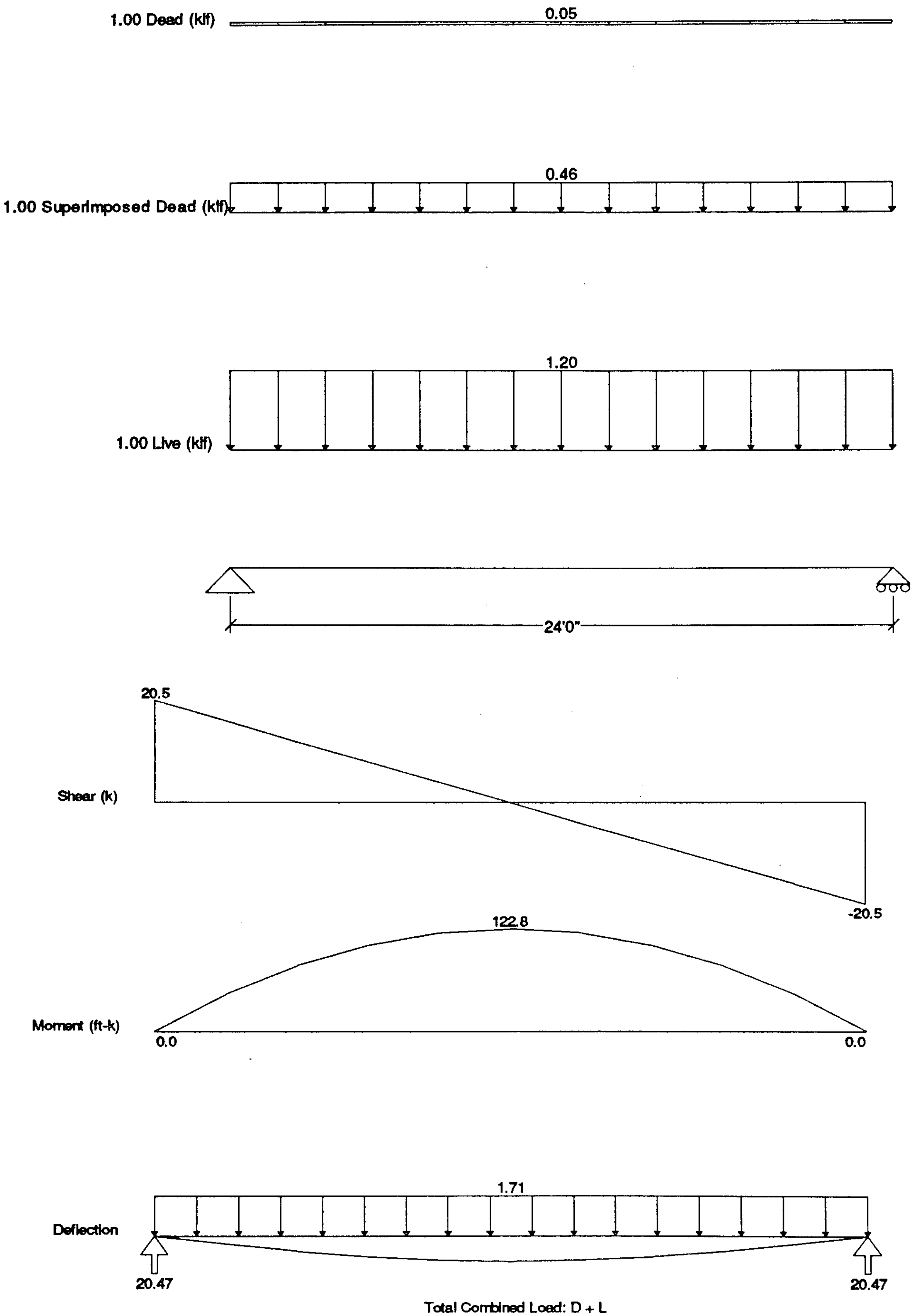
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct

View Shear, Moment & Deflection Diagrams

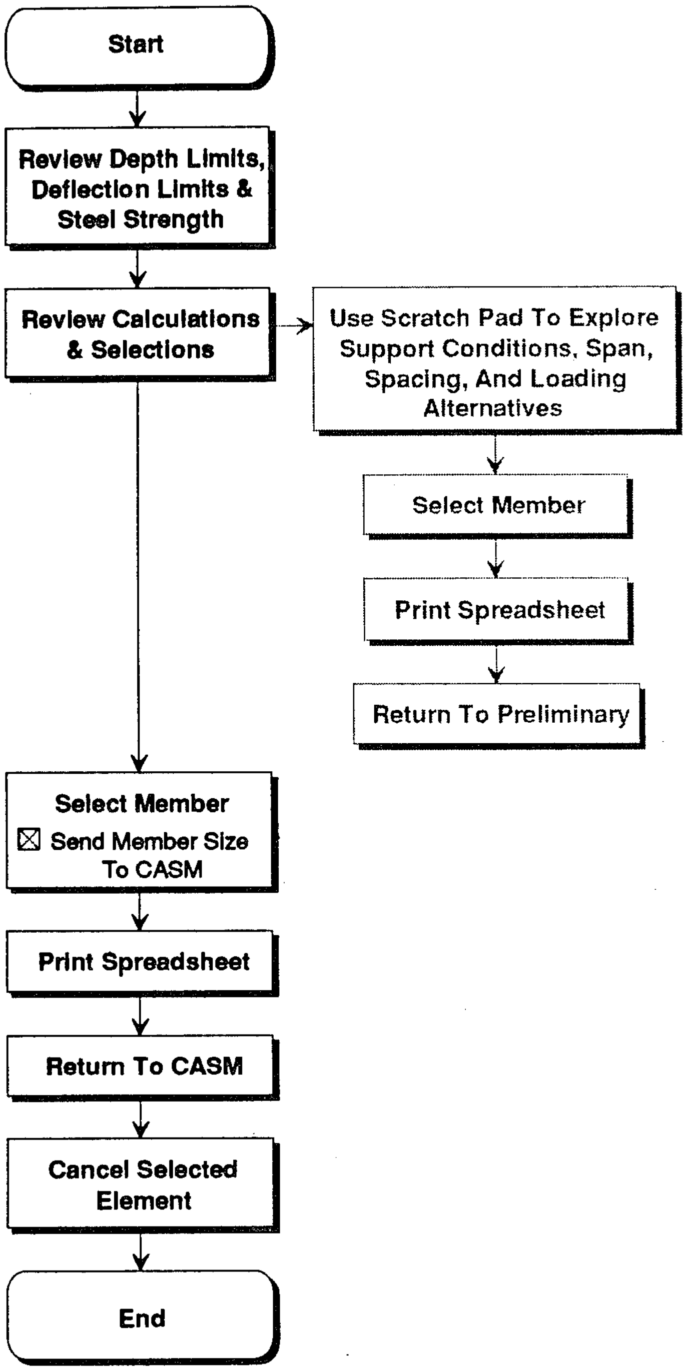
Excel Data
◉ Execute Excel



End


1.00 Dead (klf)
0.05
1.00 Superimposed Dead (klf)
0.46
1.00 Live (klf)
1.20
24'0"
Shear (k)
20.5
-20.5
Moment (ft-k)
122.8
0.0
0.0
Deflection
1.71
20.47
20.47
Total Combined Load: D + L

Steel Beam Design



STEEL BEAM PRELIMINARY SELECTION

Project: **Office Building - Scheme A**	**Date:** Aug 31, 1994
Location: **Radford AAP**	**Engr:**

CASM Load & Analysis Data:

Method: Analysis

Member ID:

Connectivity: Hinge (Left) Roller (Right)

Beam Span: 24.0 ft

Trib Width= 8.0 ft

Depth Limit= **36.0** in. max

Fy= **36.0** ksi

Fb=.66*Fy= 24.0 ksi

Fv= 14.4 ksi

E = 29,000 ksi

Live Ld Defl= **L/360** =0.80 in

Total Defl= **L/240** =1.20 in

Load Combination: D + L

Load Type	Factored Moments (k-ft) Left	Mid	Right	Fact. Reactions Left(k)	Right(k)
Dead		3.6		0.6	0.6
Sup Dead		32.8		5.5	5.5
Live		86.4		14.4	14.4
Lmin Roof					
Snow					
Wind					
Summary		122.8		20.5	20.5

Max: M=	122.8 k-ft	R=	20.5 kips
Sx(req)=	61.4 in^3	Ix(req)=	386.1 in^4

CASM Beam Selection Table:

Beam	Depth d (in)	Width bf (in)	Ix (in^4)	Sx (in^3)	Live Ld Defl (in)	Total Ld Defl (in)	Shear fv (ksi)	Bending fb (ksi)	Beam Wt (lb)
W 14 x 43	13.7	8.00	428	63	-0.72	-1.03	4.9	23.5	1,032
W 12 x 50	12.2	8.08	394	65	-0.78	-1.11	4.5	22.8	1,200
W 16 x 40	16.0	7.00	518	65	-0.60	-0.85	4.2	22.8	960
W 18 x 40	17.9	6.02	612	68	-0.50	-0.72	3.6	21.5	960
W 14 x 48	13.8	8.03	485	70	-0.64	-0.91	4.4	21.0	1,152

CASM Steel Beam Selection:

							Live / Total	
W 16 x 40	Span= 24.0 ft	Ix=	518	Sx=	65	Defl(in):	-0.60	-0.85
		fv=	4.2	fb=	22.8	Beam Wt(tons)=		0.48

Notes:

1. Steel beam properties from ASD - AISC Steel Construction Manual, 9th edition

Widely Spaced Element Analysis: Girder

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

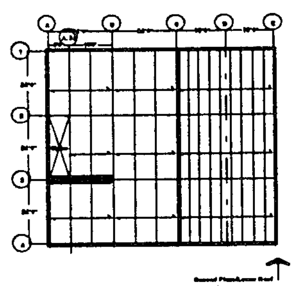
Material Steel

Select Element To Analyze & Design

Linear Widely Spaced Rolled Section

Select Widely Spaced Element A3-B3

Review Element Attributes & Guidelines



Load Combination D + L

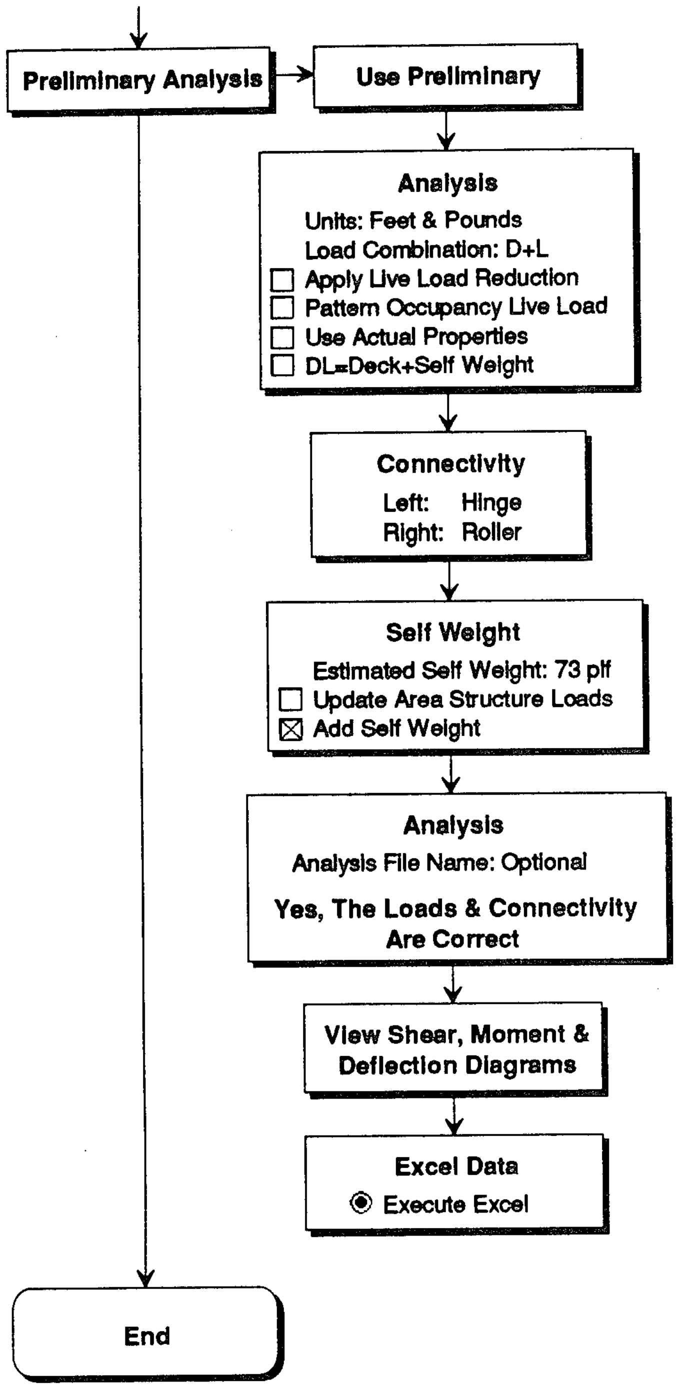
Use Load Combination

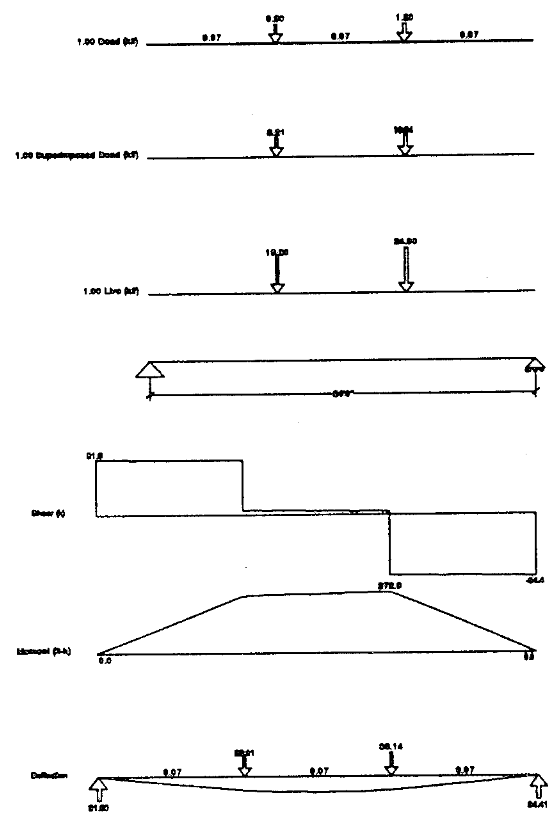
Set Factors
Dead: 1.0
Live: 1.0

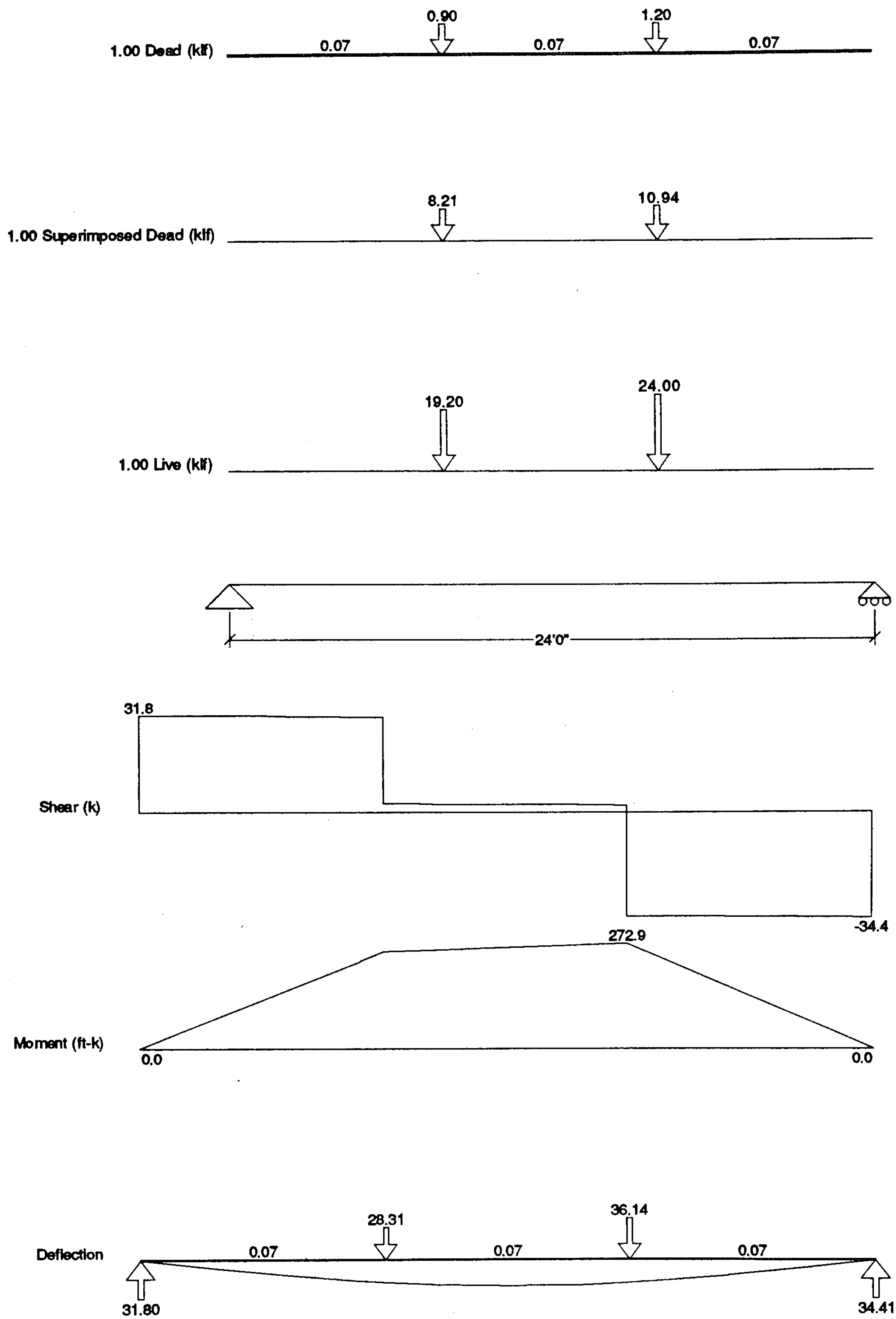
Add

OK Button To Close Dialog Window

Highlight D+L In List

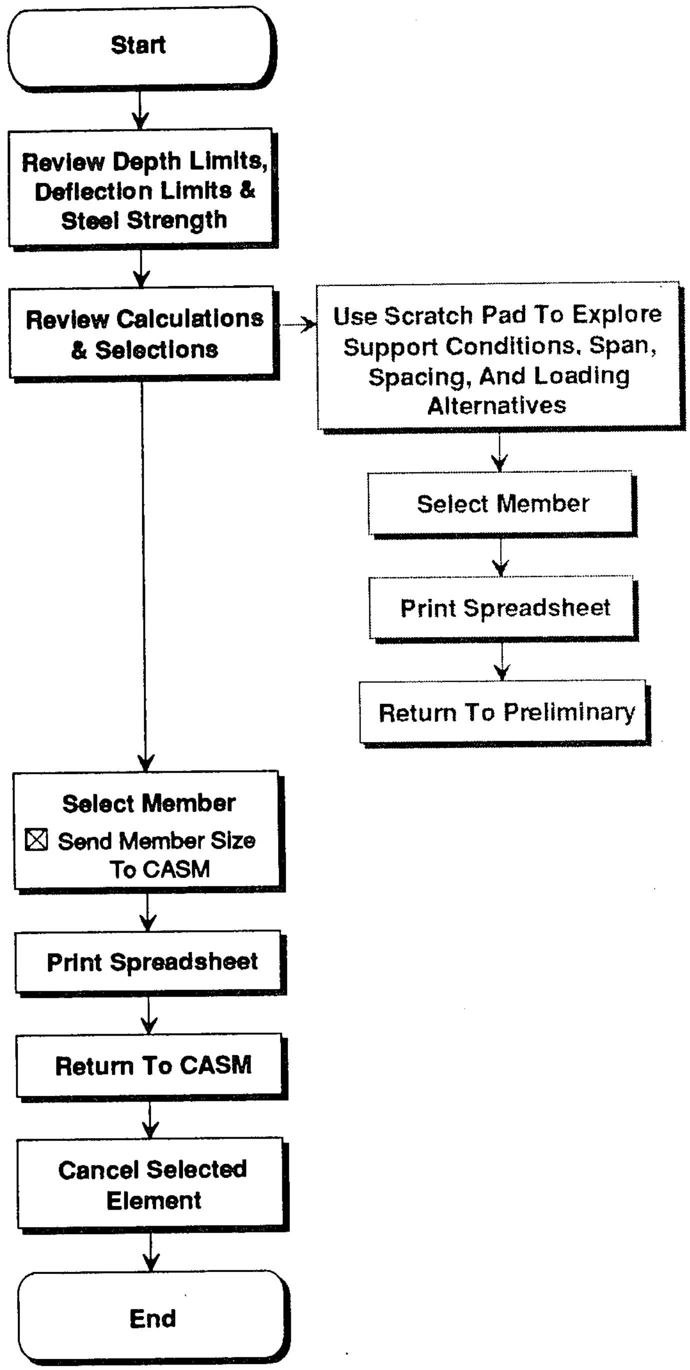

Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: D+L
Apply Live Load Reduction
Pattern Occupancy Live Load
Use Actual Properties
DL=Deck+Self Weight
Connectivity
Left: Hinge
Right: Roller
Self Weight
Estimated Self Weight: 73 plf
Update Area Structure Loads
Add Self Weight
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End





Total Combined Load: D + L

Steel Beam Design



STEEL BEAM PRELIMINARY SELECTION

Project: Office Building - Scheme A	**Date:** Aug 31, 1994
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis
Member ID:
Connectivity: Hinge (Left), Roller (Right)
Beam Span: 24.0 ft
Trib Width= 12.0 ft
Depth Limit= **36.0** in. max
Fy= **36.0** ksi
Fb=.66*Fy= 24.0 ksi
Fv= 14.4 ksi
E = 29,000 ksi
Live Ld Defl= **L/360** =0.80 in
Total Defl= **L/240** =1.20 in

Load Combination: D + L

Load Type	Factored Moments (k-ft) Left	Mid	Right	Fact. Reactions Left(k)	Right(k)
Dead		13.7		1.9	2.0
Sup Dead		80.3		9.1	10.0
Live		179.2		20.8	22.4
Lmin Roof					
Snow					
Wind					
Summary		272.9		31.8	34.4

Max: M= 272.9 k-ft	R= 34.4 kips
Sx(req)= 136.5 in^3	Ix(req)= 789.4 in^4

CASM Beam Selection Table:

Beam	Depth d (in)	Width bf (in)	Ix (in^4)	Sx (in^3)	Live Ld Defl (in)	Total Ld Defl (in)	Shear fv (ksi)	Bending fb (ksi)	Beam Wt (lb)
W 21 x 68	21.1	8.27	1,480	140	-0.43	-0.65	3.8	23.4	1,632
W 14 x 90	14.0	14.52	999	143	-0.63	-0.96	5.6	22.9	2,160
W 12 x 106	12.9	12.22	933	145	-0.68	-1.03	4.4	22.6	2,544
W 18 x 76	18.2	11.04	1,330	146	-0.47	-0.72	4.4	22.4	1,824
W 21 x 73	21.2	8.30	1,600	151	-0.39	-0.60	3.6	21.7	1,752

CASM Steel Beam Selection:

				Live / Total
	Span= 24.0 ft	Ix=	Sx=	Defl(in):
		fv=	fb=	Beam Wt(tons)=

Notes:

1. Steel beam properties from ASD - AISC Steel Construction Manual, 9th edition

Truss Element Analysis

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

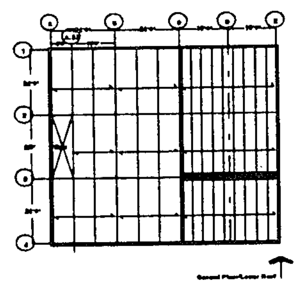
Material Steel

Select Element To Analyze & Design

Linear Truss-Custom

Select A Truss

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads

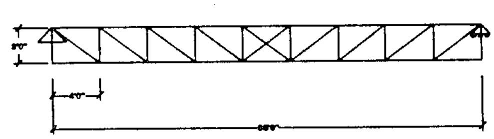
Use Compare Min. Roof LL & Snow Loads

Analysis
Units: Feet & Pounds

Connectivity
Left: Hinge
Right: Roller

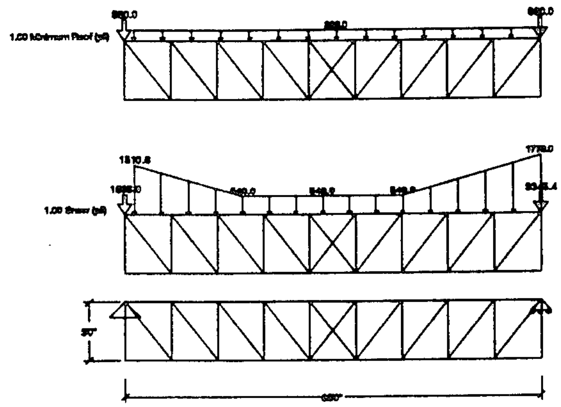
Truss - Custom

Pratt		☐ Verticals
Top Chord Panels:	9	☐ Start At Bottom
Depth At Supports:	3'	☒ Left Support At Top
Scissors Height:	0'	☒ Right Support At Top



Compare Min. Roof LL & Snow Loads

- **Snow Load Options**
  - ◉ Combined Snow Loads
- **Minimum Roof (LL)**
- **Compare Min. Roof LL & Snow Loads**
- **View Shear, Moment & Deflection Diagrams**



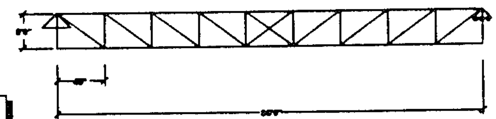
Load Combination D + S

- **Use Load Combination**
- **Set Factors**
  - Dead: 1.0
  - Snow: 1.0
- **Add**
- **OK Button To Close Dialog Window**
- **Highlight D+S In List**

Preliminary Analysis

- **Use Preliminary**
- **Analysis**
  - Units: Feet & Pounds
  - Load Combination: D+S
  - ☐ Use Actual Properties
  - ☐ DL=Deck+Self Weight
- **Connectivity**
  - Left: Hinge
  - Right: Roller

Preliminary Analysis



Truss - Custom

Pratt
Top Chord Panels: 9
Depth At Supports: 3'
Scissors Height: 0'

☐ Verticals
☐ Start At Bottom
☒ Left Support At Top
☒ Right Support At Top

Try Other Configurations

Snow Load Options

◉ Combined Snow Loads

Self Weight

Guidelines

Find Estimate For 36' Span & Flat Pitch

Close Self Weight Guidlines Dialog Window

Self Weight

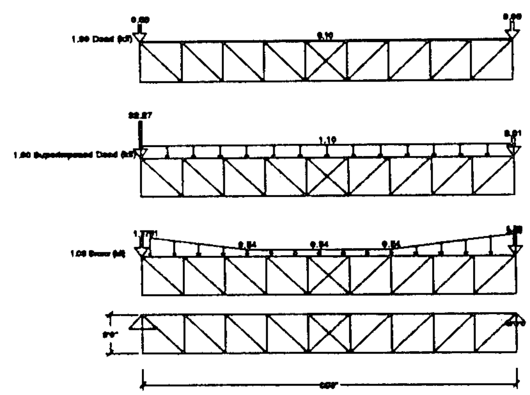
Estimated Self Weight: 96 plf
☐ Update Area Structure Loads
☒ Add Self Weight

4 plf x 24' o.c.

Analysis

Analysis File Name: Optional

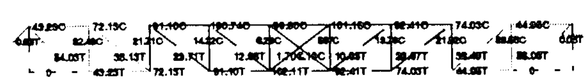
Yes, The Loads & Connectivity Are Correct



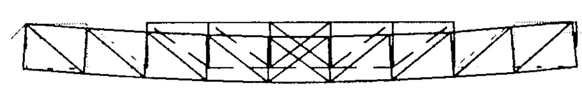
View Axial, Reactions & Deflection Diagrams

Excel Data

◉ Execute Excel

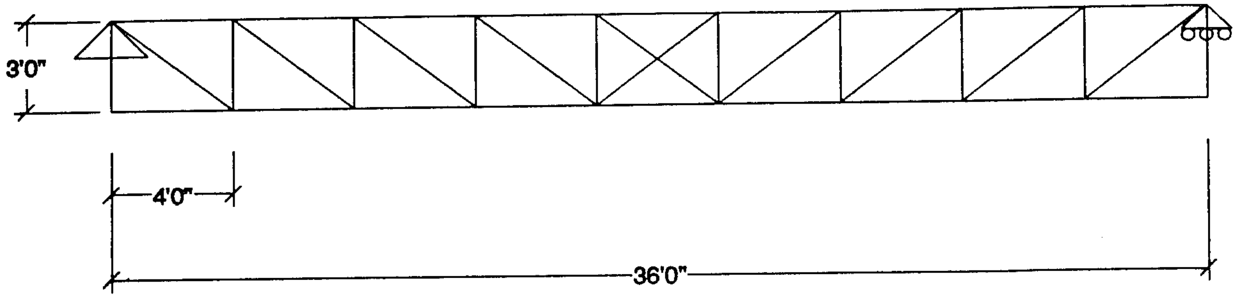


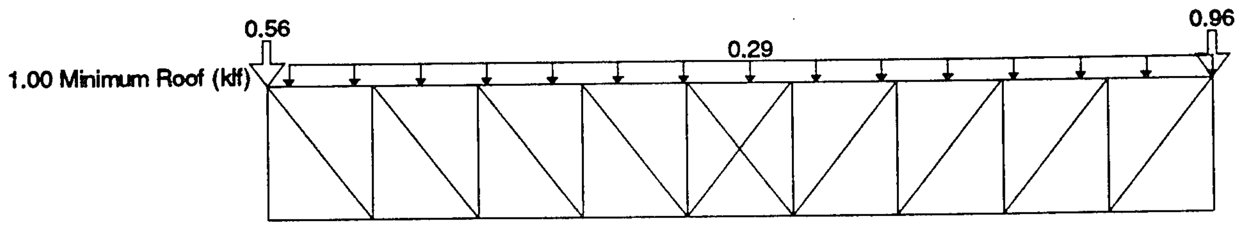
Total Combined Load: D + S – Axial (k)

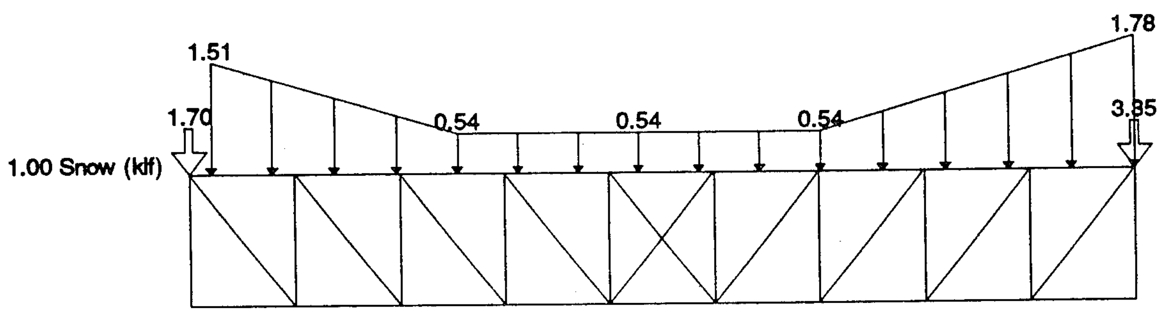


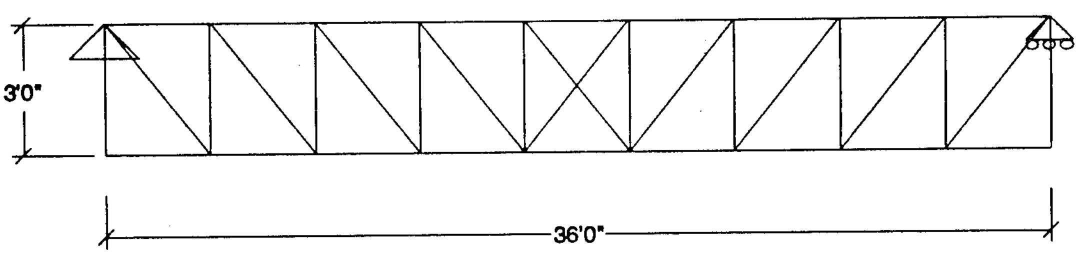
Total Combined Load: D + S – Deflection

End


3'0"
4'0"
36'0"


0.56
0.29
0.96
1.00 Minimum Roof (klf)


1.51
1.78
1.70
0.54
0.54
0.54
3.35
1.00 Snow (klf)

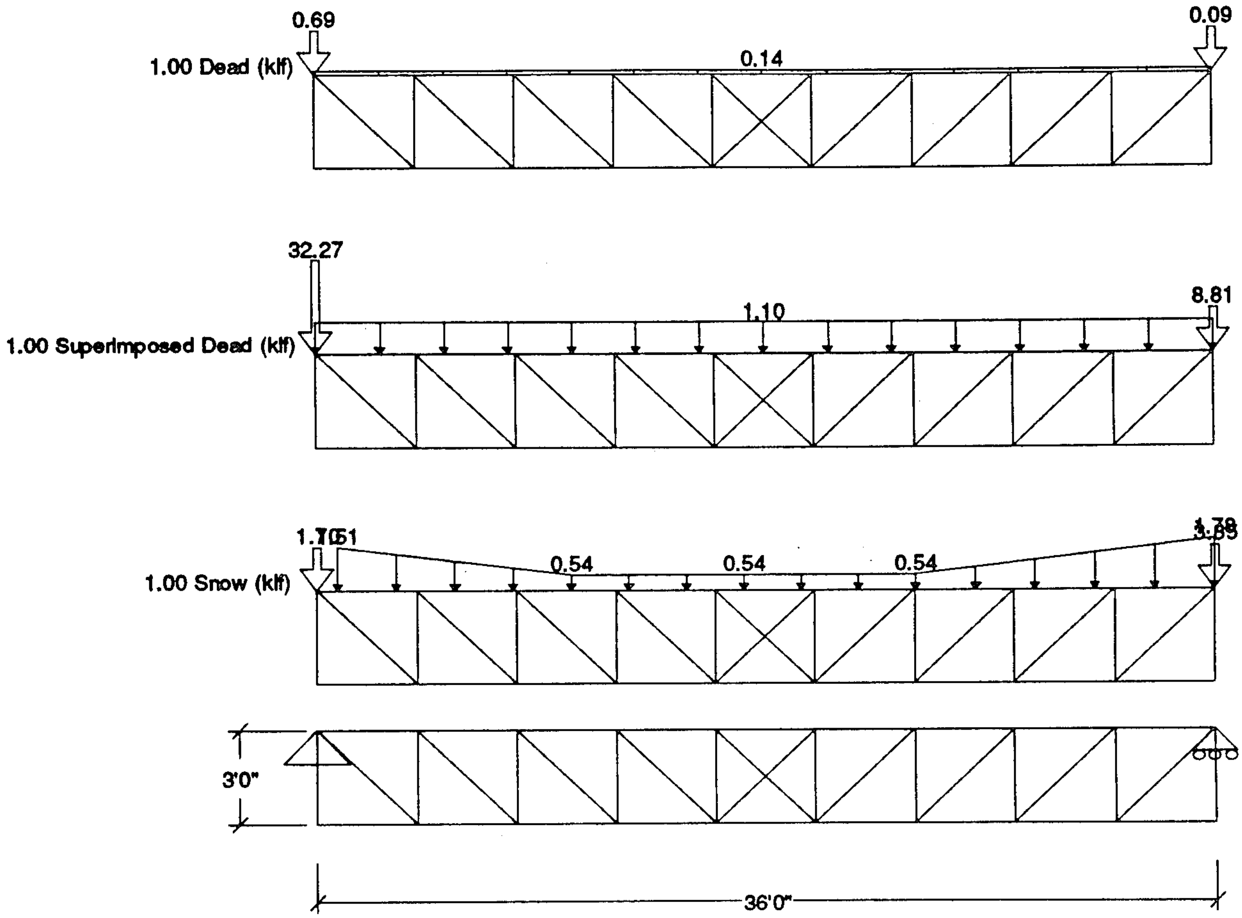

3'0"
36'0"

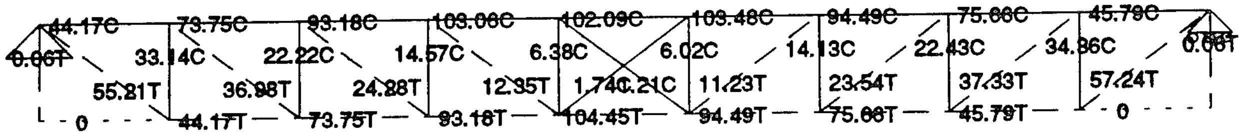
```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load : TM 5-809-1 1992
Time         : Wed Aug 31, 1994  11:27 AM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 144.0 sqft
Roof Slope     (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200         R1 = 1.00
F <= 4            R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 20.00 psf     |
+------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.


Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load : TM 5-809-1 1992
Time         : Wed Aug 31, 1994  11:27 AM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 48.0 sqft
Roof Slope     (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200         R1 = 1.00
F <= 4            R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 20.00 psf     |
+------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.


Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load : TM 5-809-1 1992
Time         : Wed Aug 31, 1994  11:27 AM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 1056.0 sqft
Roof Slope     (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
```

```
At >= 600        R1 = 0.60
F <= 4           R2 = 1.00
Lr = 12.00 psf
Minimum Lr = 12.0 psf
+-------------------------+
|     Lr = 12.00 psf      |
+-------------------------+
```

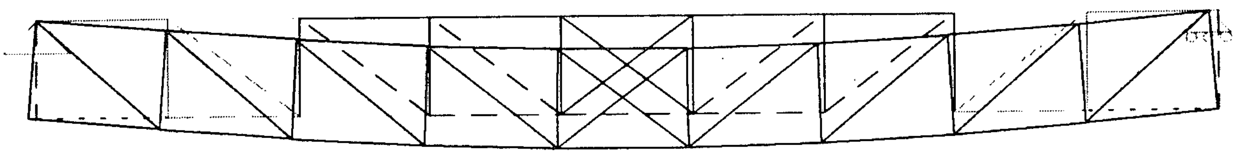
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof decking and rafters, a concentrated live load with 250 lbs uniformly distributed over an area of 2.0 ft square (4.0 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.

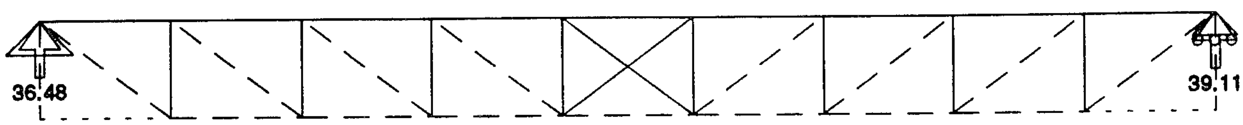




Total Combined Load: D + S -- Axial (k)

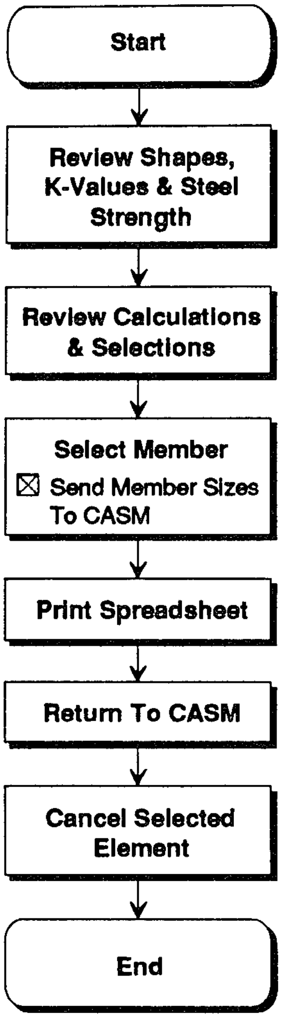


Total Combined Load: D + S -- Deflection



Total Combined Load: D + S -- Reactions (k)

Steel Truss Design



STEEL TRUSS PRELIMINARY DESIGN

Project: Office Building - Scheme A	**Date:** Aug 31, 1994
Location: Radford AAP	**Engr:**

Load & Analysis Data:

Method: Analysis
Member ID:
Connectivity: Hinge (Left), Roller (Right)
Truss Span: 12.25 ft
Spacing: 24.00 ft

Fy= **36.0** ksi
Ft= 21.6 ksi
E= 29,000 ksi
Cc= 126.1

Load Combination: D + S

Load Type	Top Chord	Bottom Chord	Tens. Web	Comp. Web
Dead	7.5	-7.6	-3.8	2.3
Sup Dead	59.0	-59.8	-30.0	18.0
Live				
Lmin Roof				
Snow	37.0	-37.1	-23.4	14.1
Wind				
Summary	103.5	-104.5	-57.2	34.4
Length	4.00	4.00	5.00	3.00

Truss Member Design Table:

Member Size	As (in^2)	rx (in)	ry (in)	Kl/r	Fa (psi)	fa (psi)	Mbr Wt(plf)
Top Chord K=1.0						**Shape Selection:**	**WT**
WT 8 x 18	5.28	2.41	1.52	31.58	19.8	19.6	18.0
WT 7 x 19	5.58	2.04	1.55	30.97	19.9	18.5	19.0
WT 5 x 19.5	5.73	1.24	1.98	38.71	19.3	18.1	19.5
Bottom Chord K=1.0						**Shape Selection:**	**WT**
WT 5 x 16.5	4.85	1.26	1.94	38.10	21.6	21.5	16.5
WT 7 x 17	5.00	2.04	1.53	31.37	21.6	20.9	17.0
WT 4 x 17.5	5.14	0.97	2.03	49.64	21.6	20.3	17.5
Tension Web K=1.0						**Shape Selection:**	**2L**
2L 2 x 2 x 3/8	2.72	0.59	0.87	101.01	21.6	21.0	9.4
2L 3.5 x 2.5 x 1/4	2.88	1.12	0.96	62.63	21.6	19.9	9.8
2L 3 x 3 x 1/4	2.88	0.93	1.26	64.52	21.6	19.9	9.8
Comp Web K=1.0						**Shape Selection:**	**2L**
2L 3 x 2.5 x 3/16	1.99	0.95	0.99	37.74	19.4	17.3	6.8
2L 2.5 x 3 x 3/16	1.99	0.76	1.30	47.31	18.6	17.3	6.8
2L 2.5 x 2 x 1/4	2.13	0.78	0.80	45.92	18.7	16.1	7.2

CASM Steel Truss Member Selection:

Top Chord:	Kl/r=	31.6		As=	5.3	Tension Web Mbr:	Kl/r=	101.0		As=	2.7
WT 8 x 18	fa=	19.6	<	Fa=	19.8	**2L 2 x 2 x 3/8**	fa=	21.0	<	Fa=	21.6
Bottom Chord:	Kl/r=	38.1		As=	4.9	Compression Web Mbr:	Kl/r=	37.7		As=	2.0
WT 5 x 16.5	fa=	21.5	<	Fa=	21.6	**2L 3 x 2.5 x 3/16**	fa=	17.3	<	Fa=	19.4

Notes:
1. Steel member properties from ASD - AISC Steel Construction Manual, 9th edition

Column Load Run Down

Start

Use Loads & Design Tool Palette

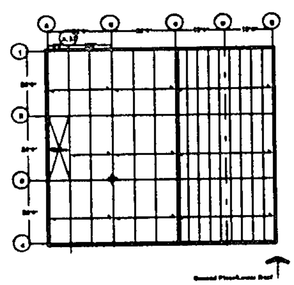
Material Steel

Live Load Reduction → Occupancy (LL)
☒ Apply Live Load Reduction

Select Element To Analyze & Design → Column Rolled Section

Select Column B3

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads → Use Compare Min. Roof LL & Snow Loads

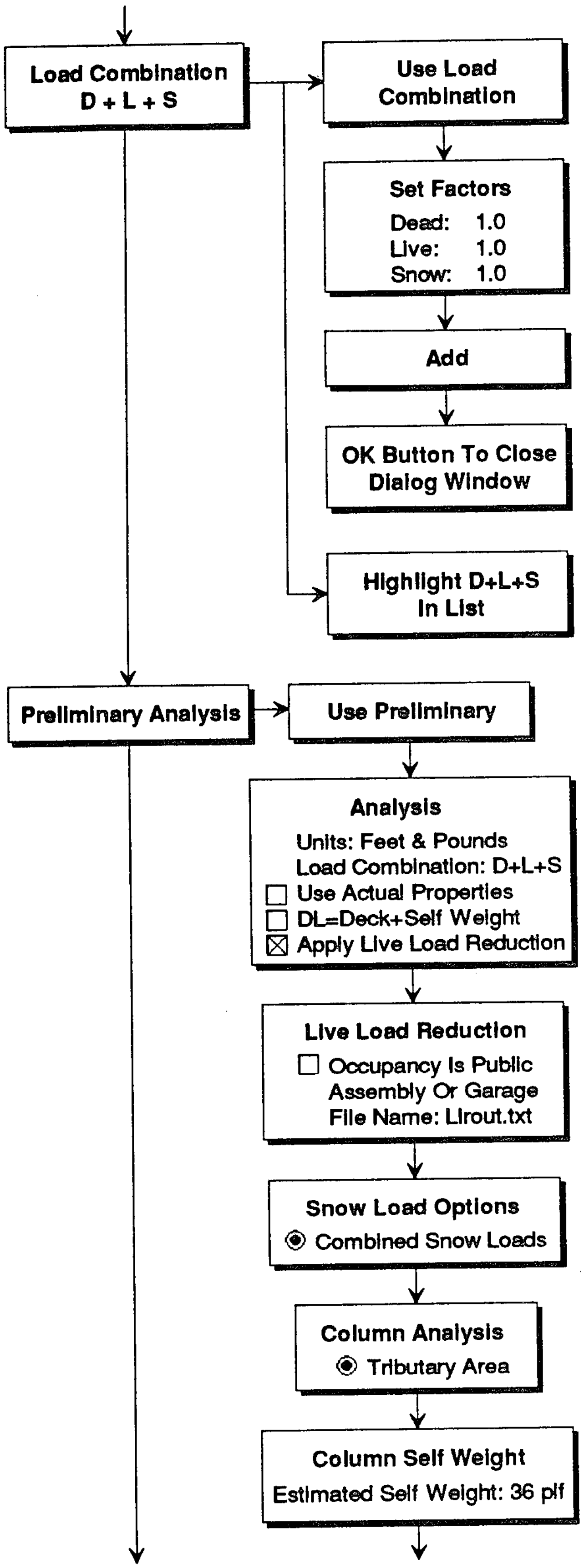
Analysis
Units: Feet & Pounds

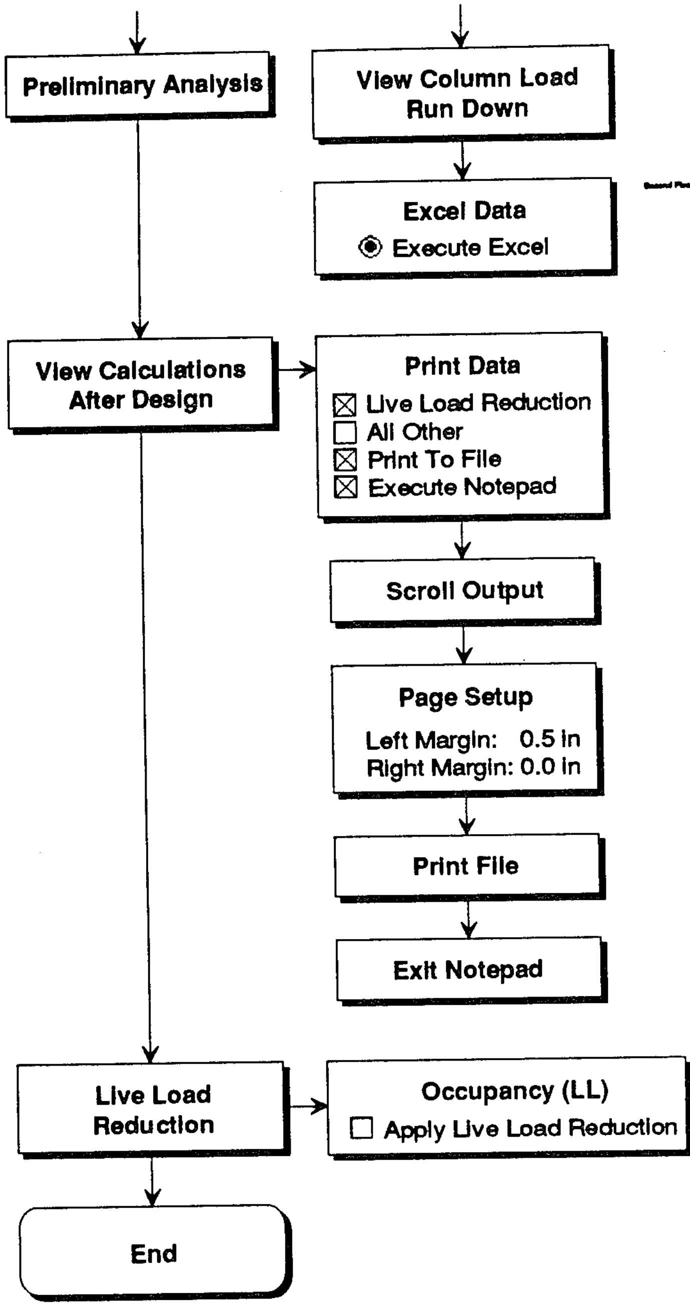
Snow Load Options
◉ Combined Snow Loads

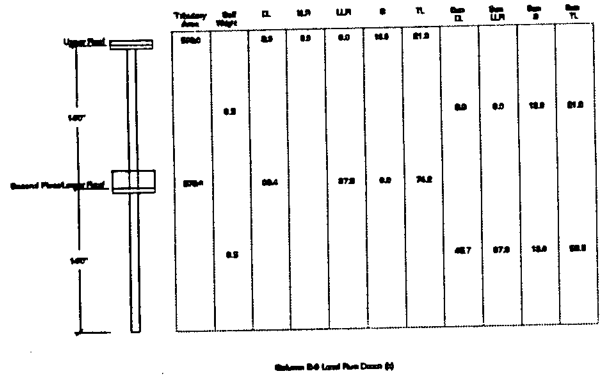
Minimum Roof (LL)

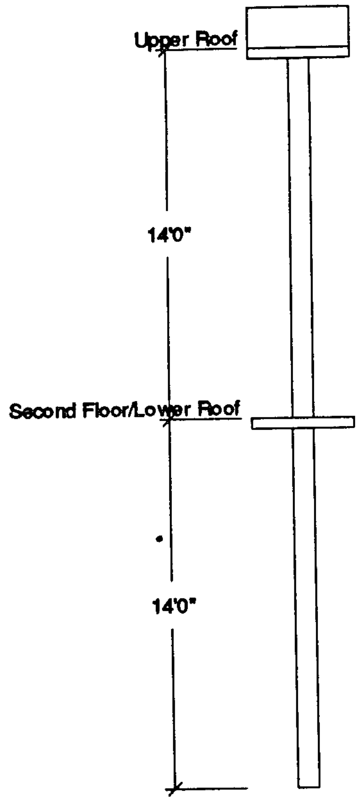
Column Analysis
◉ Tributary Area

Compare Min. Roof LL & Snow Loads


Load Combination
D + L + S
Use Load Combination
Set Factors
Dead: 1.0
Live: 1.0
Snow: 1.0
Add
OK Button To Close Dialog Window
Highlight D+L+S In List
Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: D+L+S
Use Actual Properties
DL=Deck+Self Weight
Apply Live Load Reduction
Live Load Reduction
Occupancy Is Public Assembly Or Garage
File Name: Llrout.txt
Snow Load Options
Combined Snow Loads
Column Analysis
Tributary Area
Column Self Weight
Estimated Self Weight: 36 plf


Preliminary Analysis
View Column Load Run Down
Excel Data
Execute Excel
View Calculations After Design
Print Data
Live Load Reduction
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
Live Load Reduction
Occupancy (LL)
Apply Live Load Reduction
End



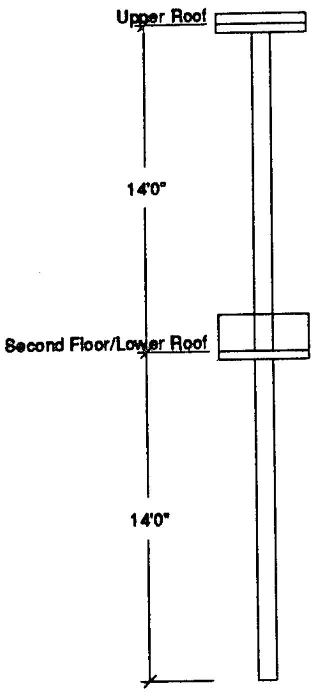


Tributary Area	Lr	S	Sum Lr	Sum S
576.0	7.2	13.0		
			7.2	13.0
576.0	0.0	0.0		
			7.2	13.0

Column B-3 Load Run Down (k)

```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Wed Aug 31, 1994   12:23 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area  (At)  : 576.0 sqft
Roof Slope      (F)   : 0.00 in 12

Lr = 20*R1*R2 >= 12
200 < At < 600   R1 = 1.2-0.001*At
                 R1 = 0.624
F <= 4           R2 = 1.00
Lr = 12.48 psf
Minimum Lr = 12.0 psf
+-------------------------+
|     Lr = 12.48 psf      |
+-------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```

Column Load Run Down

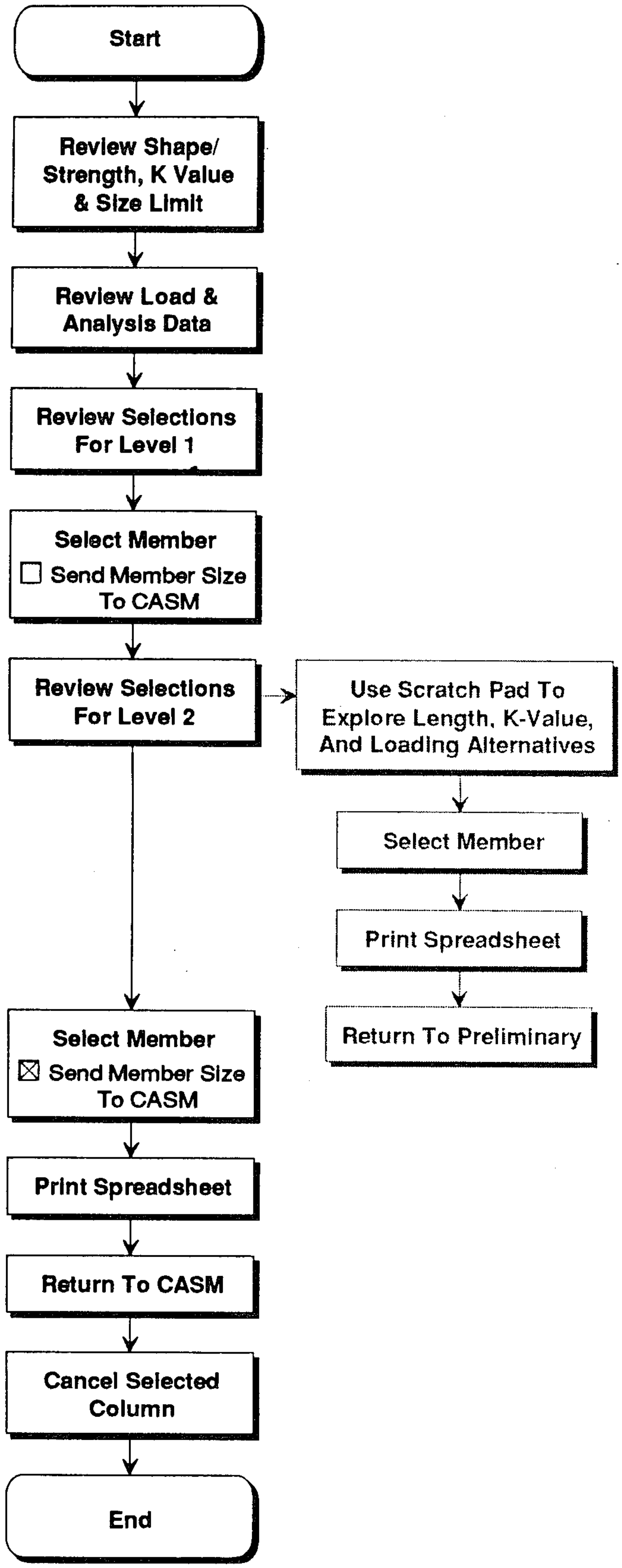


Tributary Area	Self Weight	DL	LLR	LLR	S	TL	Sum DL	Sum LLR	Sum S	Sum TL
576.0		8.3	0.0	0.0	13.0	21.3				
	0.5						8.8	0.0	13.0	21.8
576.0		36.4		37.8	0.0	74.2				
	0.5						45.7	37.8	13.0	96.5

Column B-3 Load Run Down (k)

```
Project     : Office Building - Scheme A
Location    : Radford AAP
Design Load : TM 5-809-1 1992
Time        : Wed Aug 31, 1994  12:25 PM

*************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Office: Offices (Lo) :   50.0 psf
Tributary area  (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo <= 100.0 psf
L = Lo*[0.25+15/sqrt(Ai)]
L = 28.1 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 25.0 psf
+-------------------------+
|     L = 28.13 psf       |
+-------------------------+

*************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Corridor: Main          (Lo) :  100.0 psf
Tributary area          (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo <= 100.0 psf
L = Lo*[0.25+15/sqrt(Ai)]
L = 56.3 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 50.0 psf
+-------------------------+
|     L = 56.25 psf       |
+-------------------------+

*************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Files & Storage         (Lo) :  150.0 psf
Tributary area          (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo > 100.0 psf
Member supports only one floor.
No live load reduction taken.
L = Lo
+-------------------------+
|     L = 150.00 psf      |
+-------------------------+
```

Steel Column Design



STEEL COLUMN PRELIMINARY SELECTION

Project: Office Building - Scheme A	**Date:** Aug 31, 1994
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis   Load Combination: D + L + S   Steel Fy= **36.0** ksi
Member ID: B-3   Size Limit= **10.0** in. max   E= 29000 ksi

Name	Level	Flr to Flr Ht	Trib Area	Floor Level Load Totals (kips) Dead	Live	Lmin	Snow	Wind	Load Totals
	6								
	5								
	4								
	3								
Upper Roof	2	14.0	576	8.8			13.0		21.8
Second Floor/L	1	14.0	576	45.7	37.8		13.0		96.5

CASM Column Selection Table

Level: **2**	Preq: 21.76 kips	K-value: **1.0**	Cc= 126.1
Col Shape: **W**	Length: 14.0 ft	kl: 14.0	

Column Size	Depth d(in)	Width bf(in)	Area (sq in)	ry (in)	kl/r	Fa (ksi)	fa (ksi)	Pallow (kip)	Weight (ton)
W 6 x 15	5.99	5.99	4.43	1.46	115.07	10.98	4.91	48.6	0.11
W 5 x 16	5.01	5.00	4.68	1.27	132.28	8.45	4.65	39.6	0.11
W 5 x 19	5.15	5.03	5.54	1.28	131.25	8.61	3.93	47.7	0.13
W 6 x 20	6.20	6.02	5.87	1.50	112.00	11.40	3.71	66.9	0.14
W 8 x 28	8.06	6.54	8.25	1.62	103.70	12.50	2.64	103.2	0.20

CASM Steel Column Selection

Column Size	Level	Depth d(in)	Width bf(in)	Area (sq in)	ry (in)	kl/r	Fa (ksi)	Pallow (kip)	Weight (ton)
W 8 x 28	2	8.06	6.54	8.25	1.62	103.70	12.50	103.2	0.20
W 8 x 28	1	8.06	6.54	8.25	1.62	103.70	12.50	103.2	0.20
							Total Column Weight:		0.39

Notes:

1. Steel column properties from ASD - AISC Steel Construction Manual, 9th edition

Lateral Resistance Philosophy

Steps Required

1. Create building volume

2. Define a structural grid

3. Layout structural framing on ALL levels

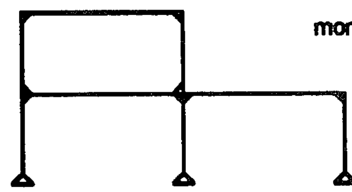
4. Assign gravity load on ALL levels
   Calculate wind and/or seismic loads

5. Select a load combination including wind or seismic loads

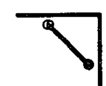
6. Define N-S & E-W vertical resistance system

   Options:

   1. Unbraced Frames

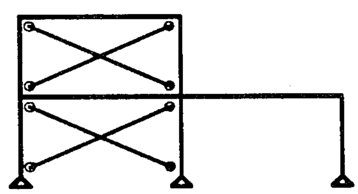


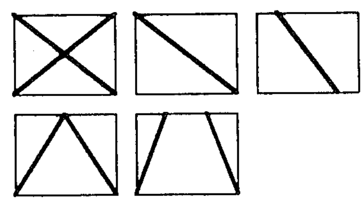
moment resistant connections
or
knee bracing



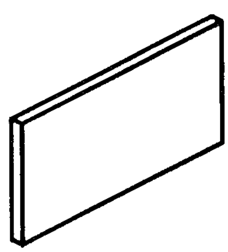
   2. Braced Frames

      A. Trussing





      B. Shear Walls

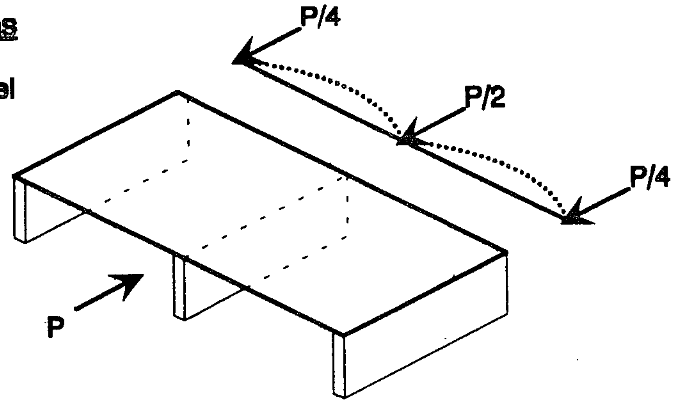


7. Define horizontal diaphragm systems

   All flexible
   All rigid
   Floors rigid & roof flexible

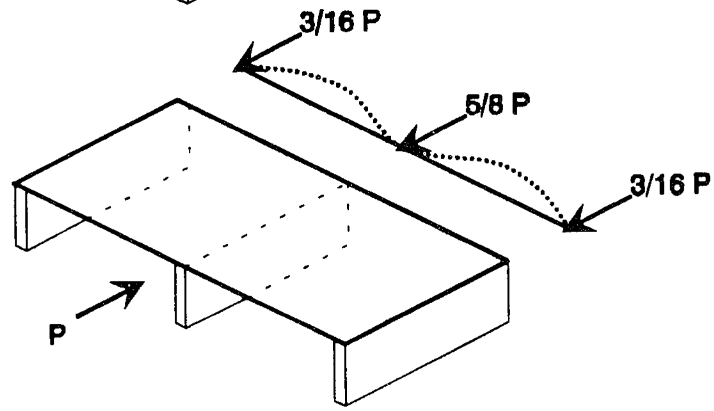
Flexible Diaphragms

Simple Beam Model
(tributary area)



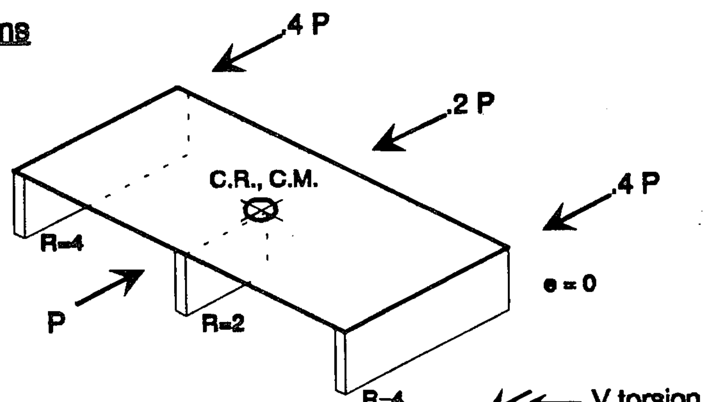
* No Torsion

Continuous Beam Model



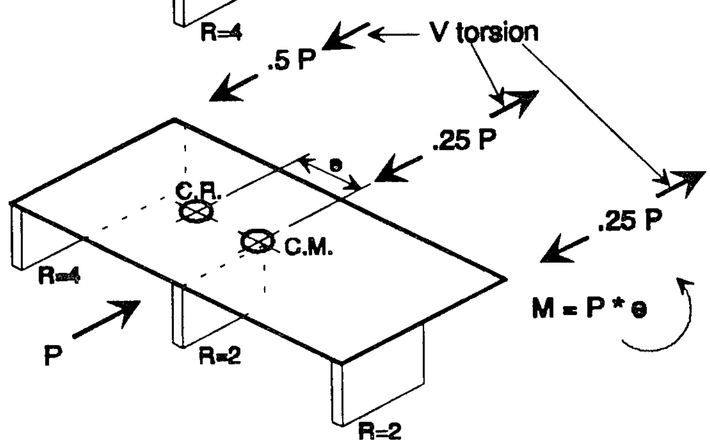
Rigid Diaphragms

Symmetrical

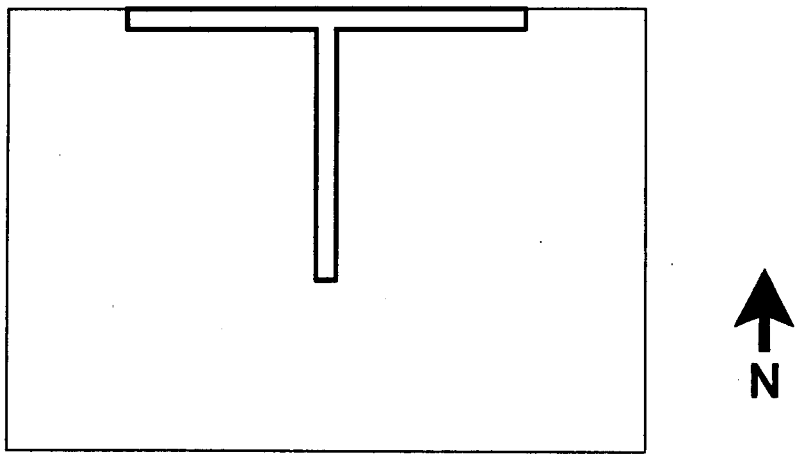


Torsion
(even accidental minimum required)

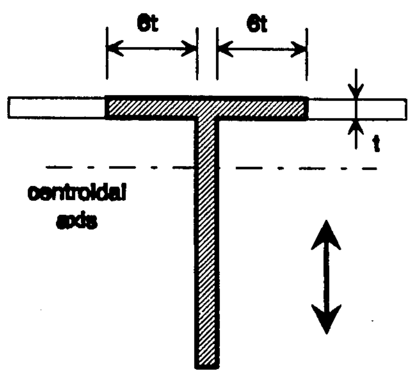
Non-Symmetrical



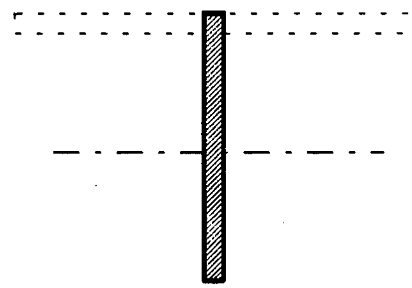
Monolithic Perpendicular Shear Walls



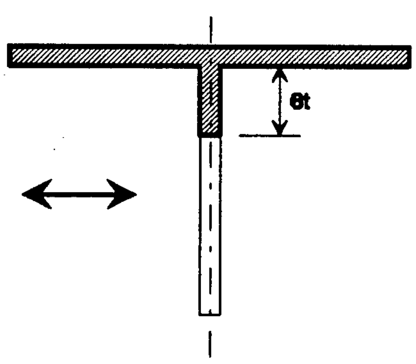
For N-S



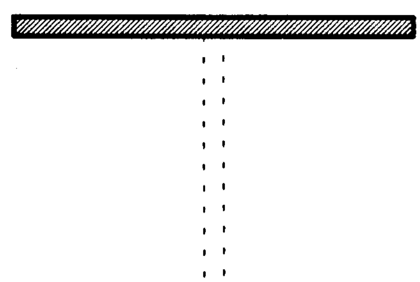
or



For E-W



or



Define Lateral Resistance

Start

Use Draw Structure Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Define Second Floor/ Lower Roof Diaphragm Type

Diaphragm Guidlines

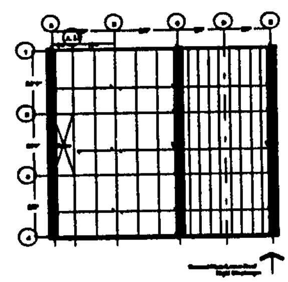
Lateral Horizontal Rigid Diaphragm

Define N-S Lateral Resistance

Define Location

Vertical Define Location

Select Beam On Grid Line A

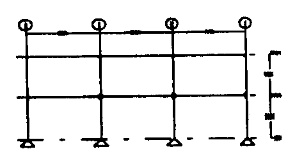


Define Bracing & Connectivity

Vertical Define Elements

Select NS-1

Define All Rigid Frame Connections



Close Lateral Resistance Dialog Window

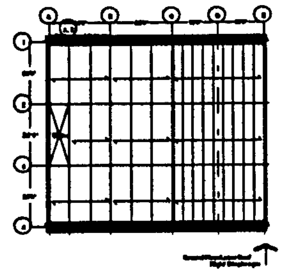
Repeat For Grid Lines C & E

Define E-W Lateral Resistance

Define Location

Vertical Define Location

Select Beam On Grid Line 1

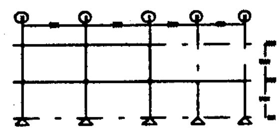


Define Bracing & Connectivity

Vertical Define Elements

Select EW-1

Define All Rigid Frame Connections



Close Lateral Resistance Dialog Window

Repeat For Grid Line 4

Define Upper Roof Diaphragm Type

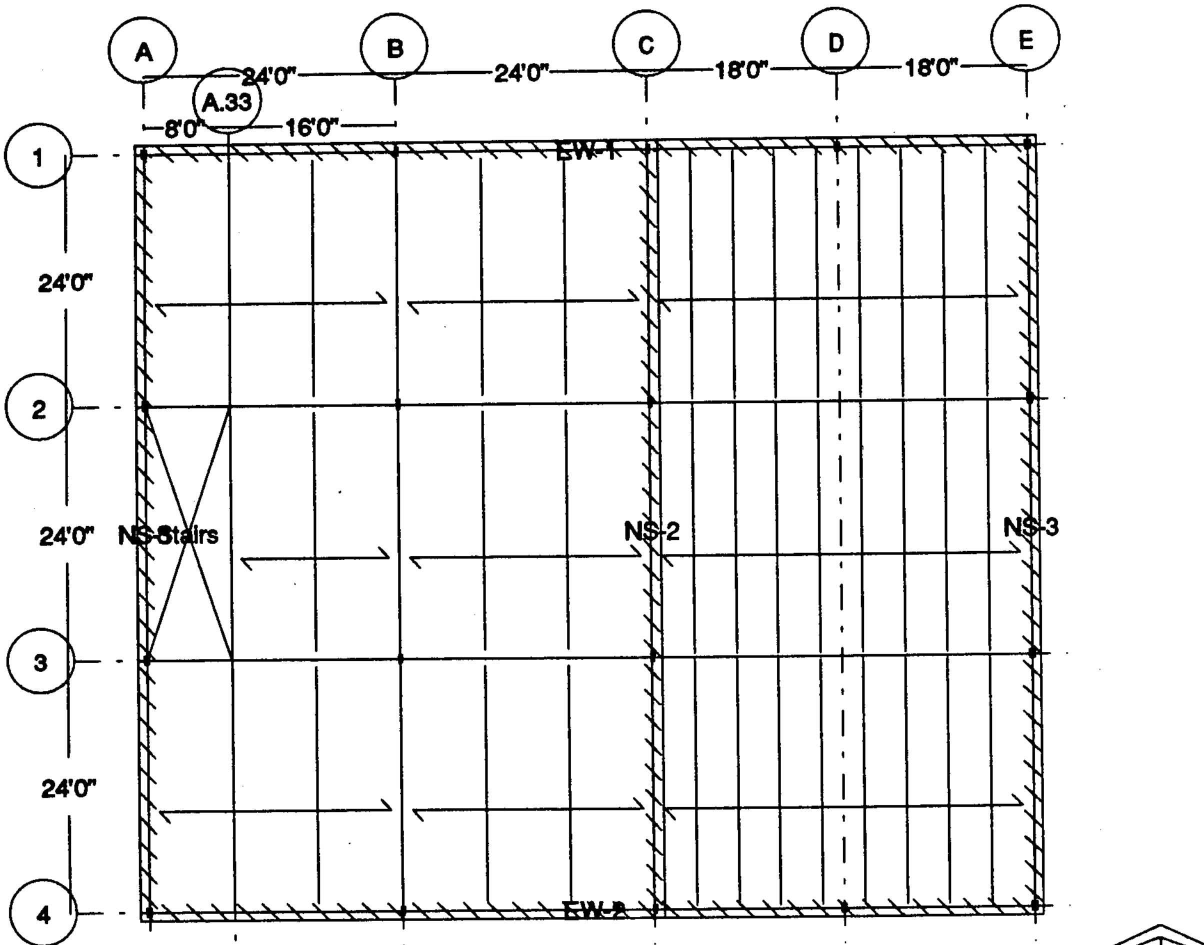
Select Upper Roof Horizontal Structural Plane

Lateral Horizontal Flexible Diaphragm

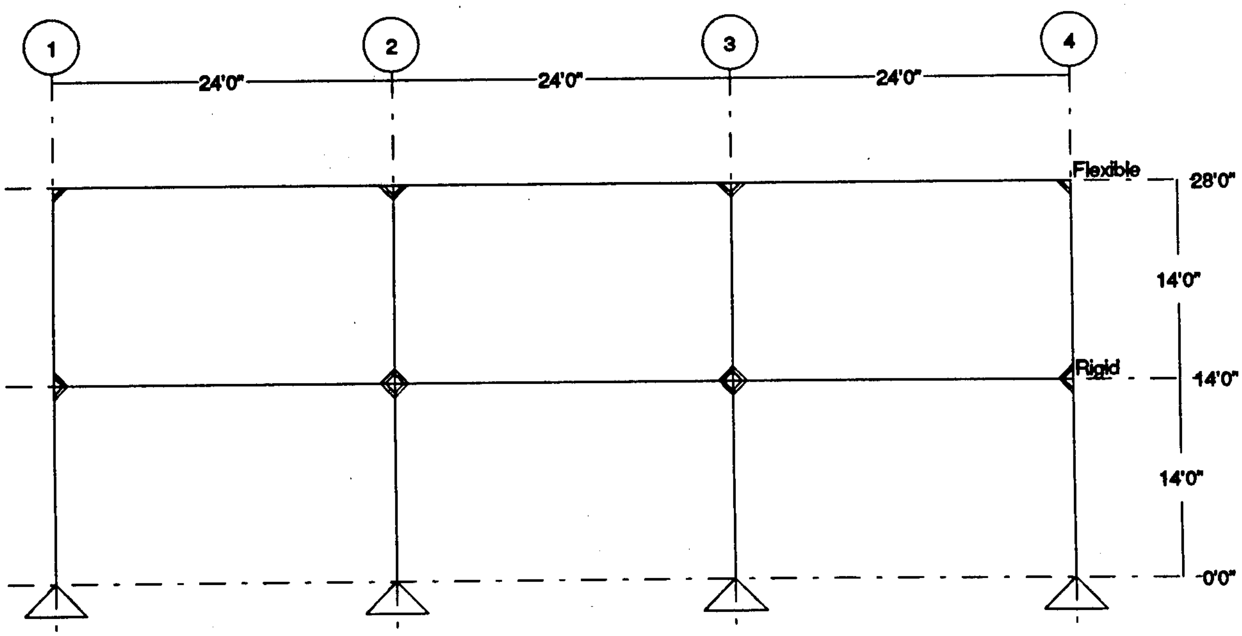
Display Lateral Resistance Locations

Show Structure
☒ NS Lateral Resistance
☐ EW Lateral Resistance

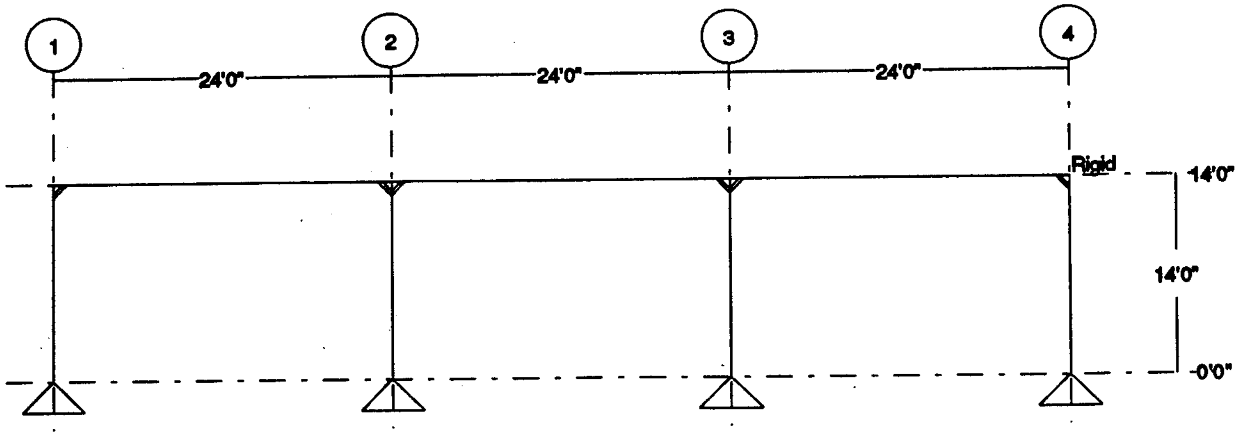
End



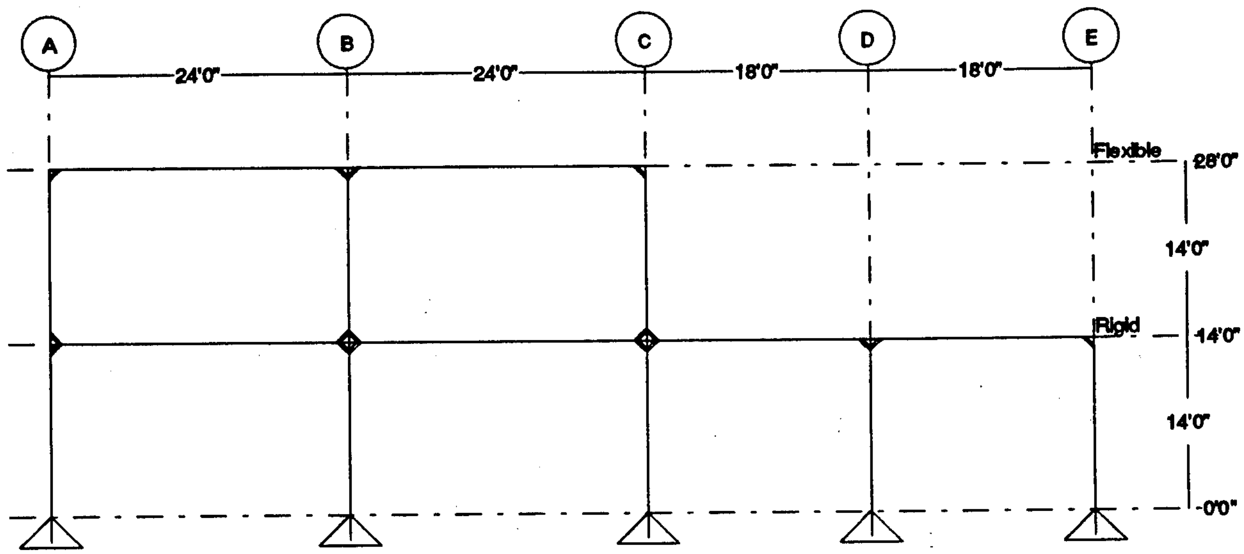
Second Floor/Lower Roof
Rigid Diaphragm



NS-1 & NS-2

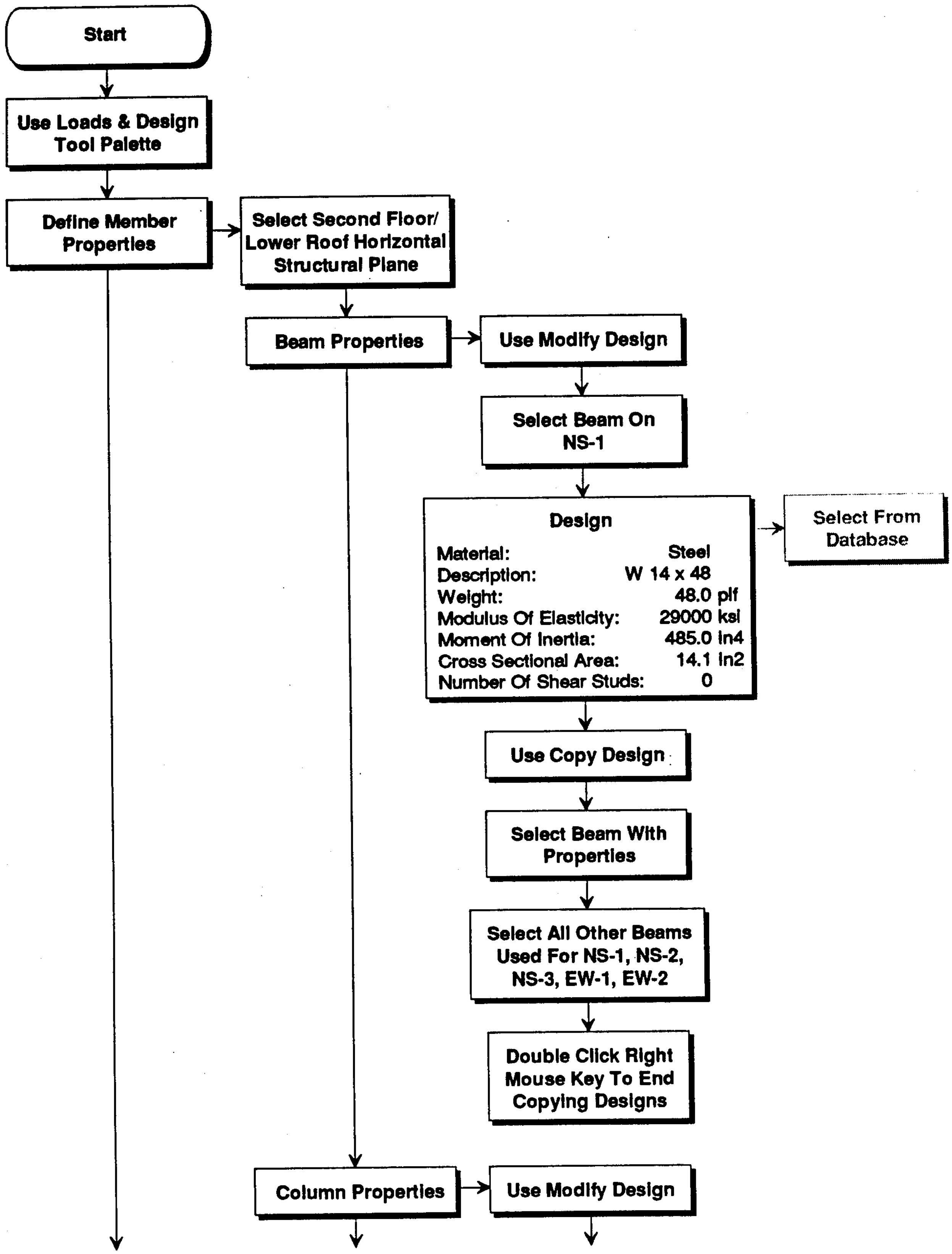

1
2
3
4
24'0"
24'0"
24'0"
Rigid
14'0"
14'0"
-0'0"

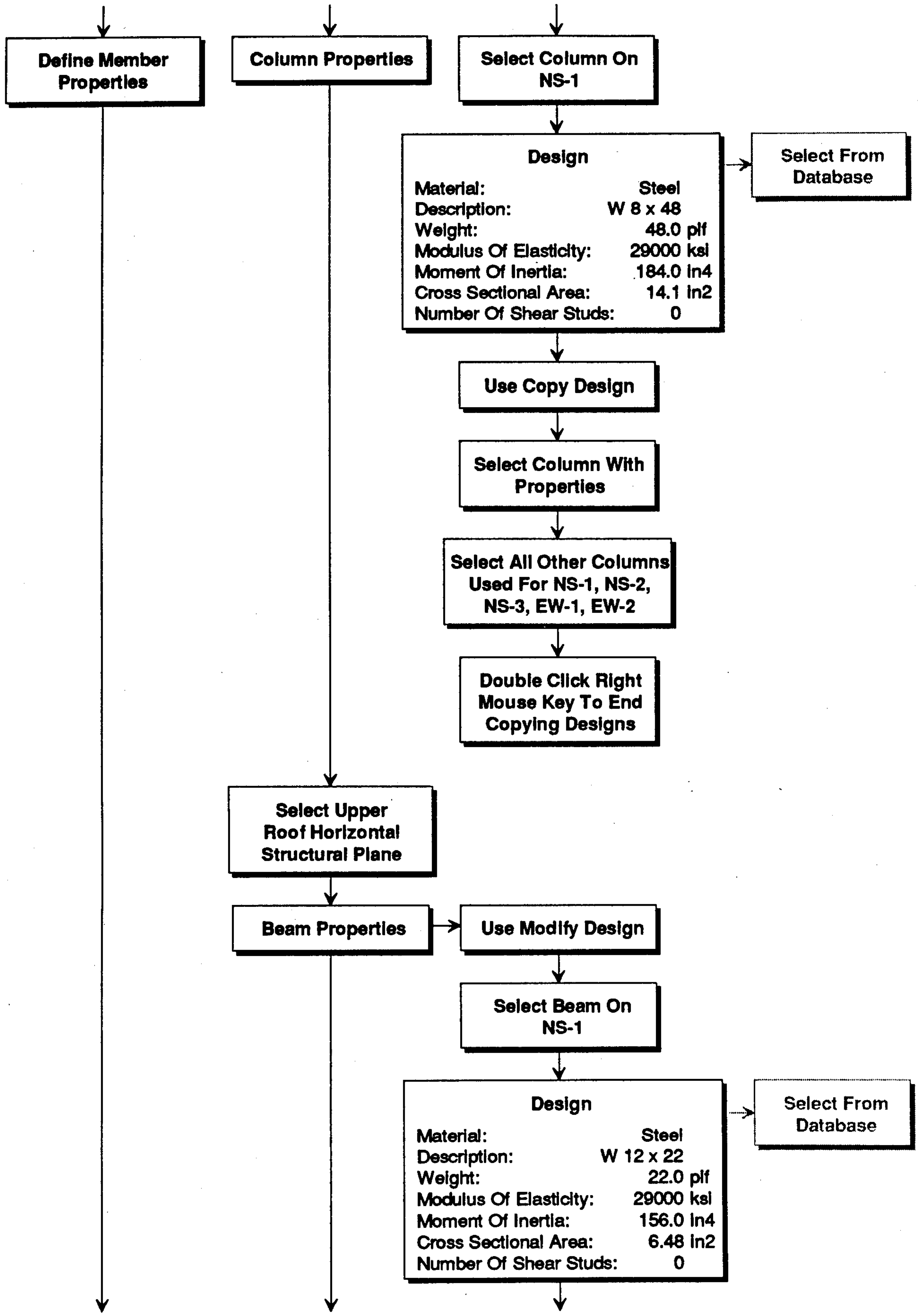
NS-3

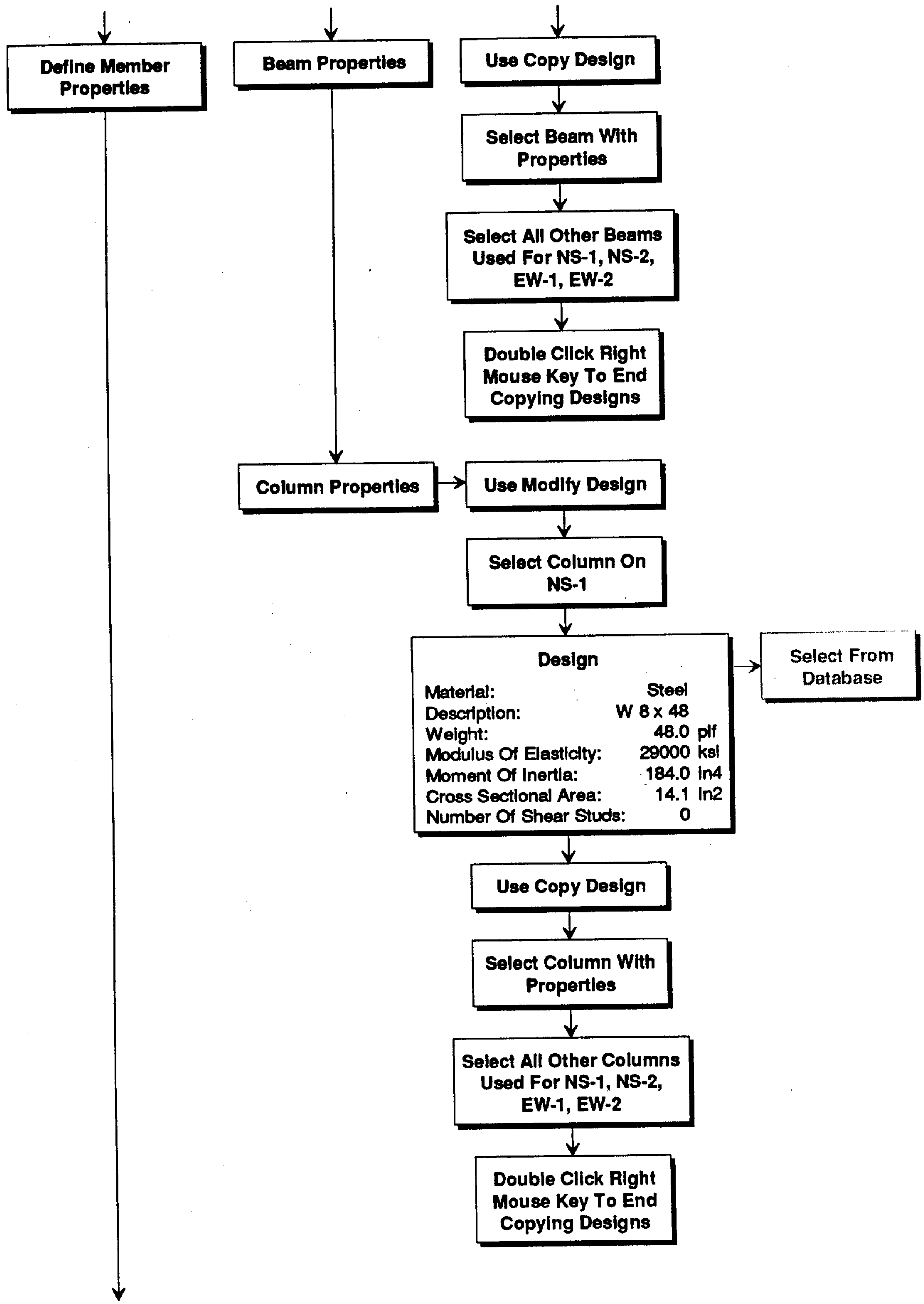

A
B
C
D
E
24'0"
24'0"
18'0"
18'0"
Flexible
28'0"
14'0"
Rigid
14'0"
14'0"
-0'0"

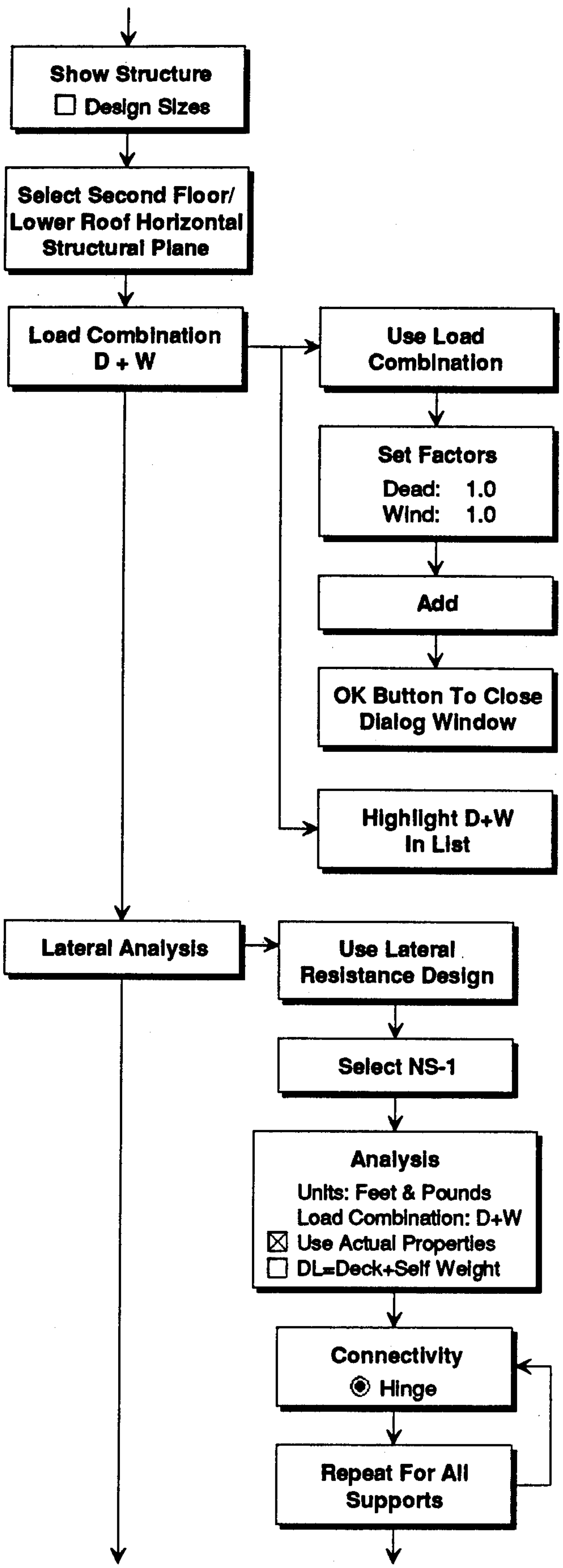
EW-1 & EW-2

Wind Lateral Analysis



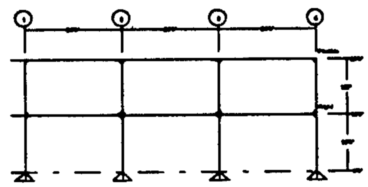

Define Member Properties
Column Properties
Select Column On NS-1
Design
Material: Steel
Description: W 8 x 48
Weight: 48.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 184.0 in4
Cross Sectional Area: 14.1 in2
Number Of Shear Studs: 0
Select From Database
Use Copy Design
Select Column With Properties
Select All Other Columns Used For NS-1, NS-2, NS-3, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs
Select Upper Roof Horizontal Structural Plane
Beam Properties
Use Modify Design
Select Beam On NS-1
Design
Material: Steel
Description: W 12 x 22
Weight: 22.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 156.0 in4
Cross Sectional Area: 6.48 in2
Number Of Shear Studs: 0
Select From Database


Define Member Properties
Beam Properties
Use Copy Design
Select Beam With Properties
Select All Other Beams Used For NS-1, NS-2, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs
Column Properties
Use Modify Design
Select Column On NS-1
Design
Material: Steel
Description: W 8 x 48
Weight: 48.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 184.0 in4
Cross Sectional Area: 14.1 in2
Number Of Shear Studs: 0
Select From Database
Use Copy Design
Select Column With Properties
Select All Other Columns Used For NS-1, NS-2, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs

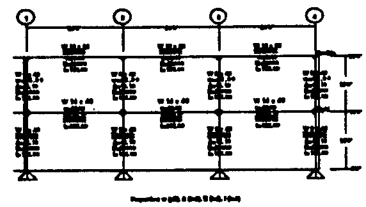

Show Structure
☐ Design Sizes
Select Second Floor/ Lower Roof Horizontal Structural Plane
Load Combination D + W
Use Load Combination
Set Factors
Dead: 1.0
Wind: 1.0
Add
OK Button To Close Dialog Window
Highlight D+W In List
Lateral Analysis
Use Lateral Resistance Design
Select NS-1
Analysis
Units: Feet & Pounds
Load Combination: D+W
☒ Use Actual Properties
☐ DL=Deck+Self Weight
Connectivity
◉ Hinge
Repeat For All Supports

Lateral Analysis

Lateral Resistance
Verify All Rigid Connections



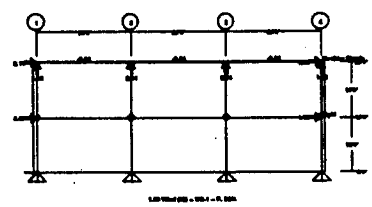
Yes, Properties Are All Correct



Wind Load Options
Wind Direction: South
When 2 Wind Loads: Max. Suction
Wind Load: GCpi = 0

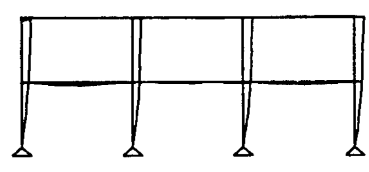
Flexible Diaphragm
◉ Simple Beam Model

Rigid Horizontal Diaphragm Calculations
File Name: Rigidout.txt
☐ Enter Deflections At Each Level



View Loads

Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct

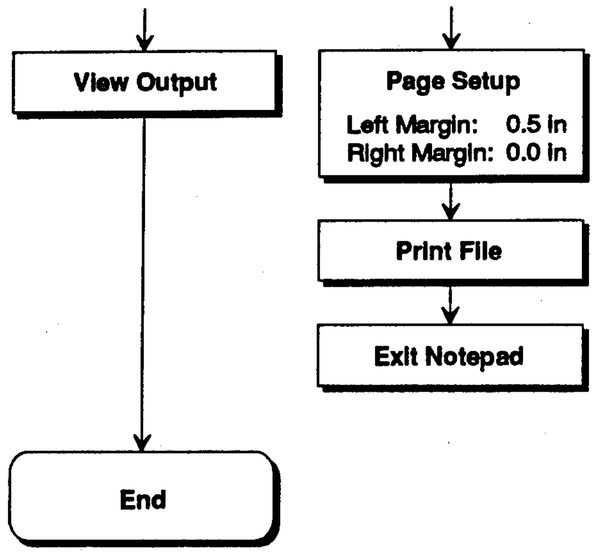


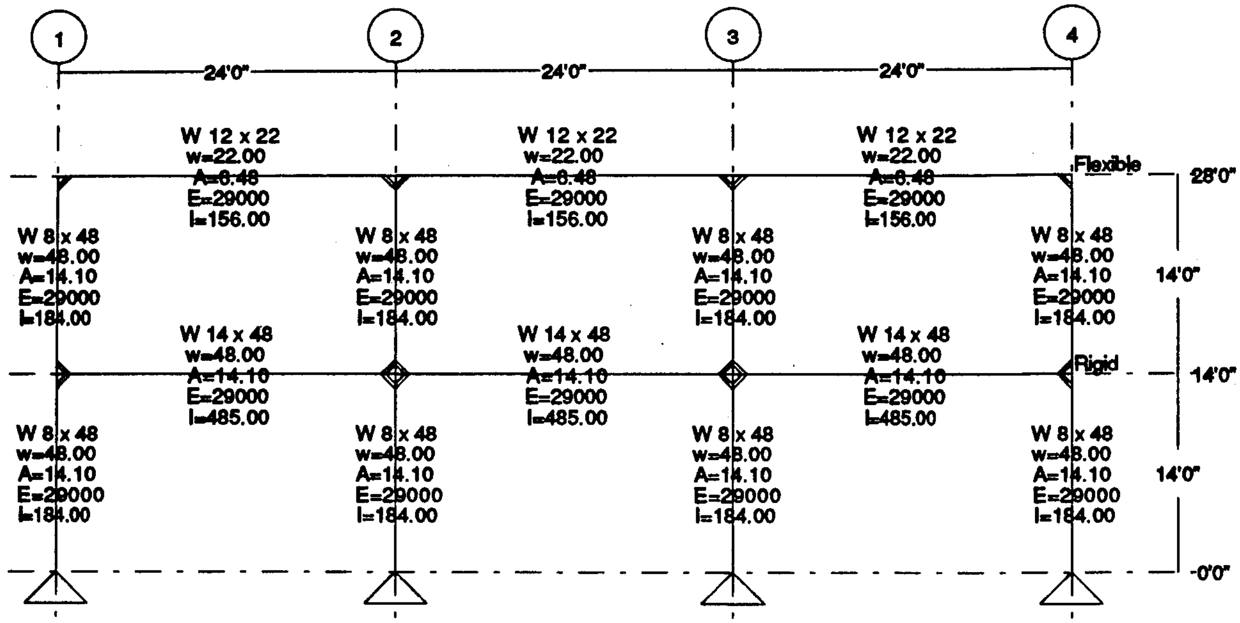
View Shear, Moment, Deflection & Reaction Diagrams

View Output

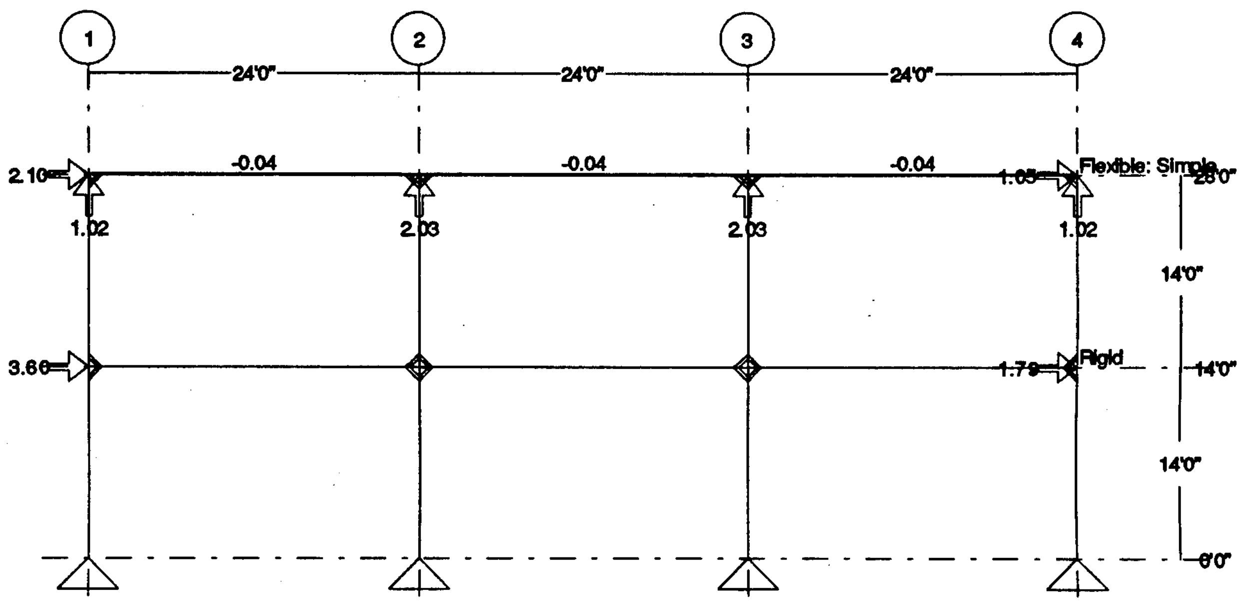
Print Data
☒ Rigid Diaphragm
☐ All Other
☒ Print To File
☒ Execute Notepad

Scroll Output

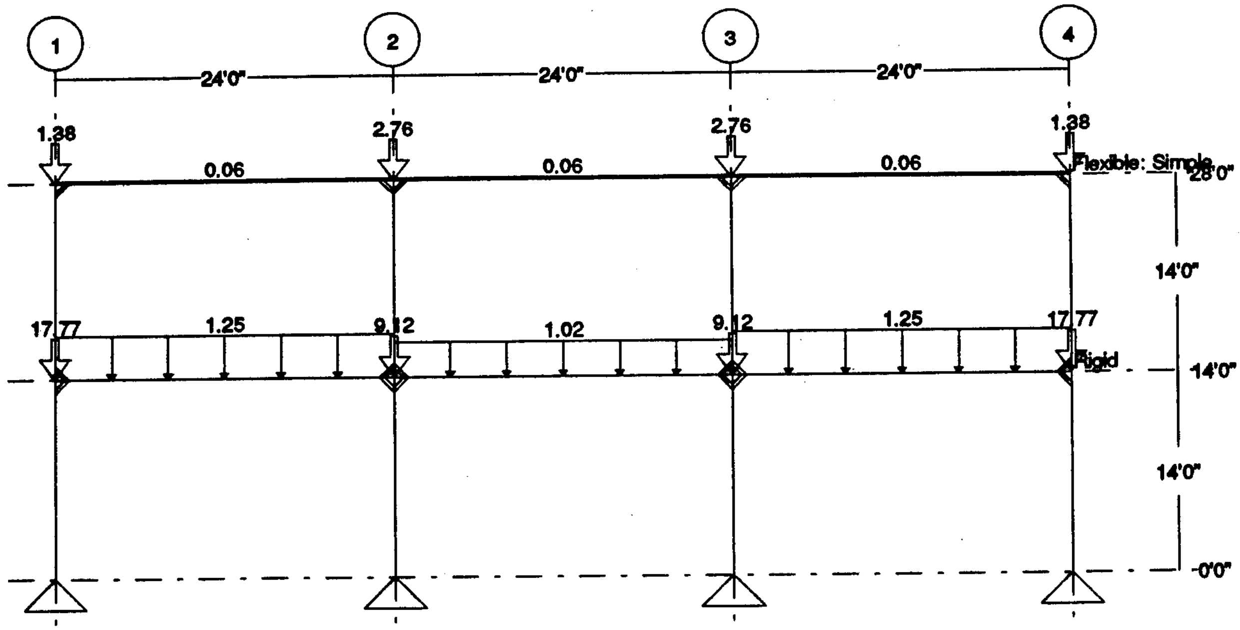

View Output
End
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad



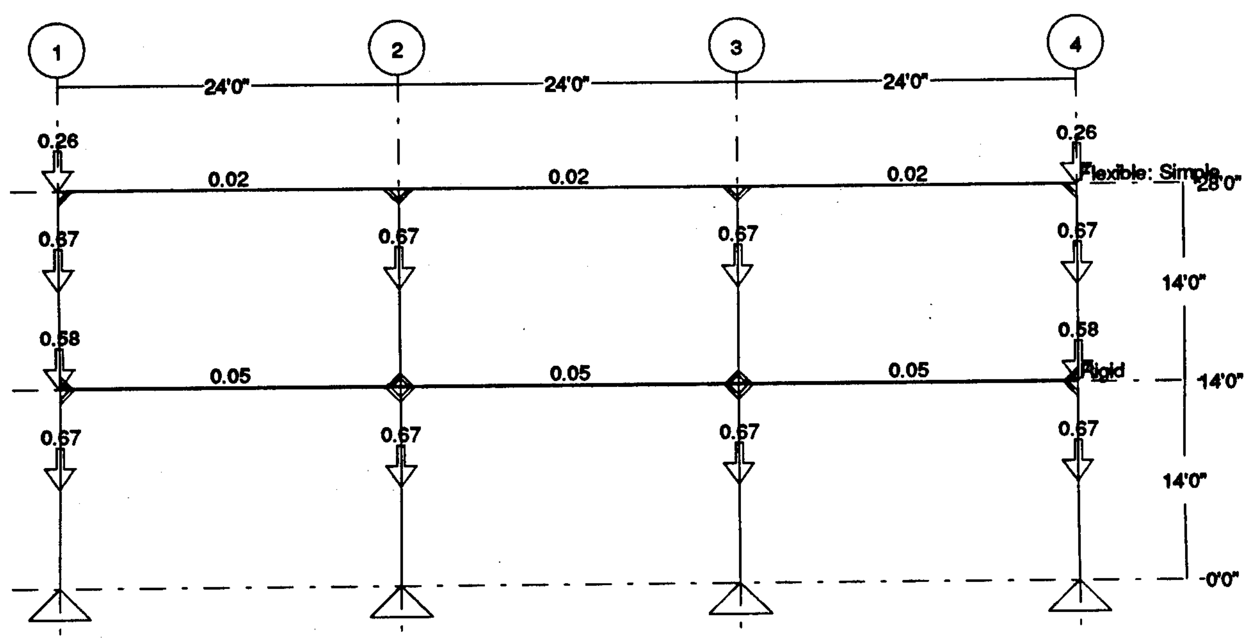
Properties: w (plf), A (in2), E (ksi), I (in4)



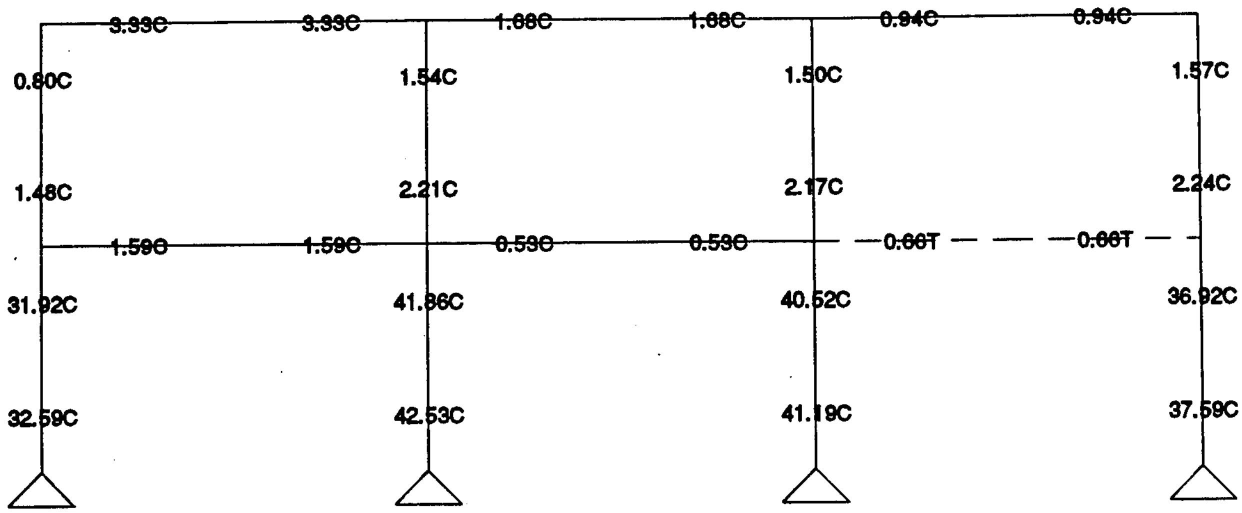
1.00 Wind (klf) – NS-1 – F, 32%



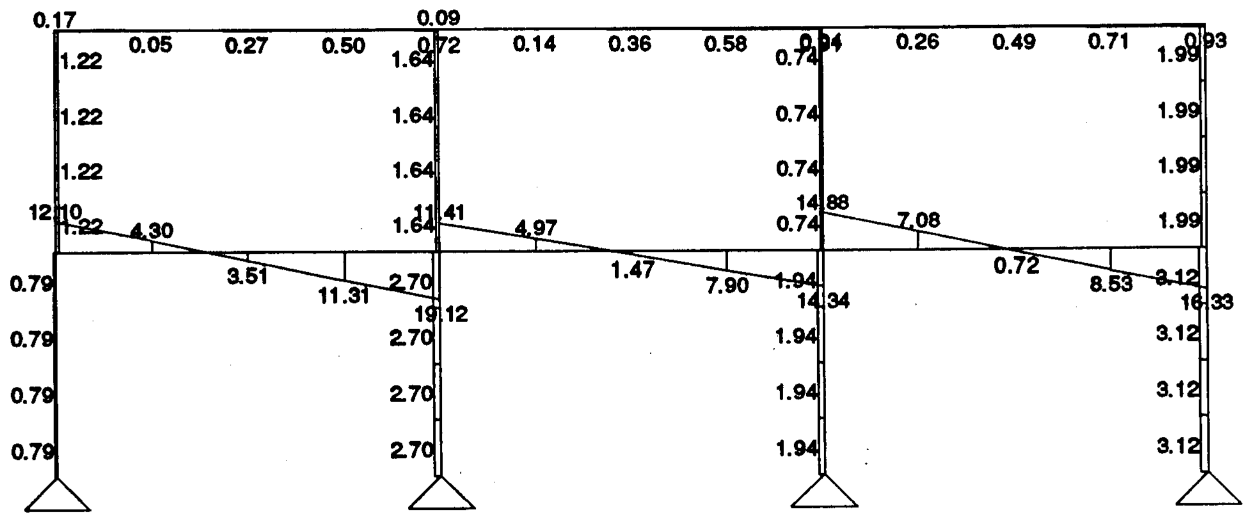
1.00 Superimposed Dead (klf) -- NS-1



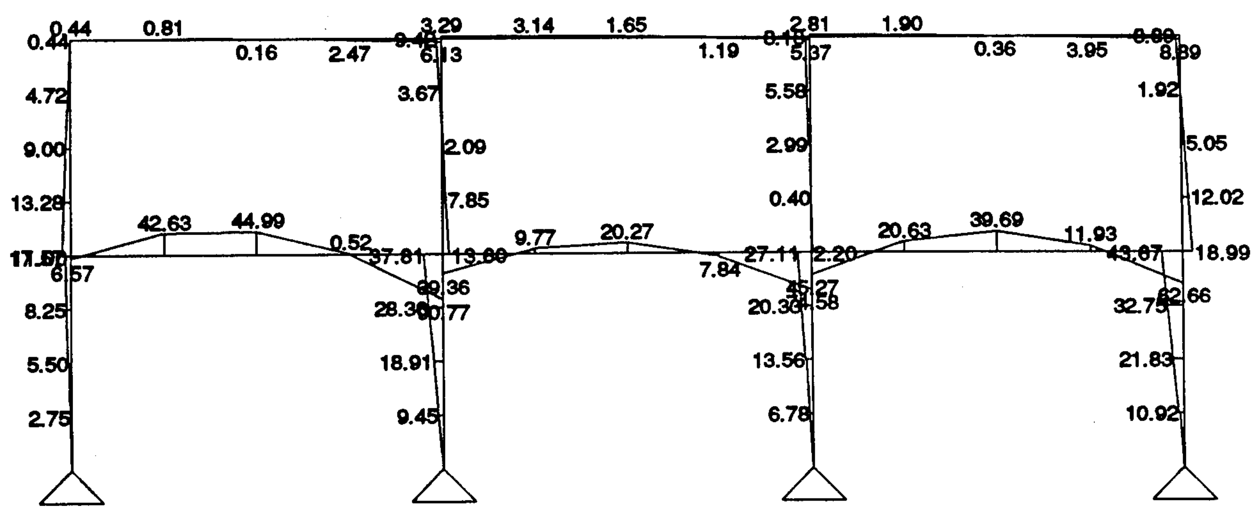
1.00 Dead (klf) -- NS-1



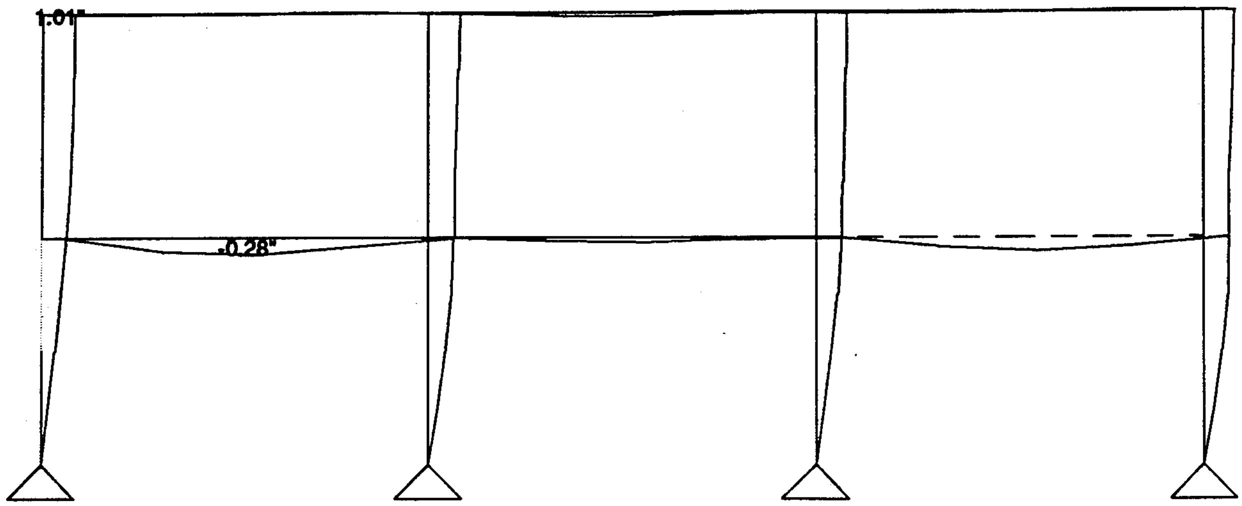
Total Combined Load: D + W -- Axial (k)



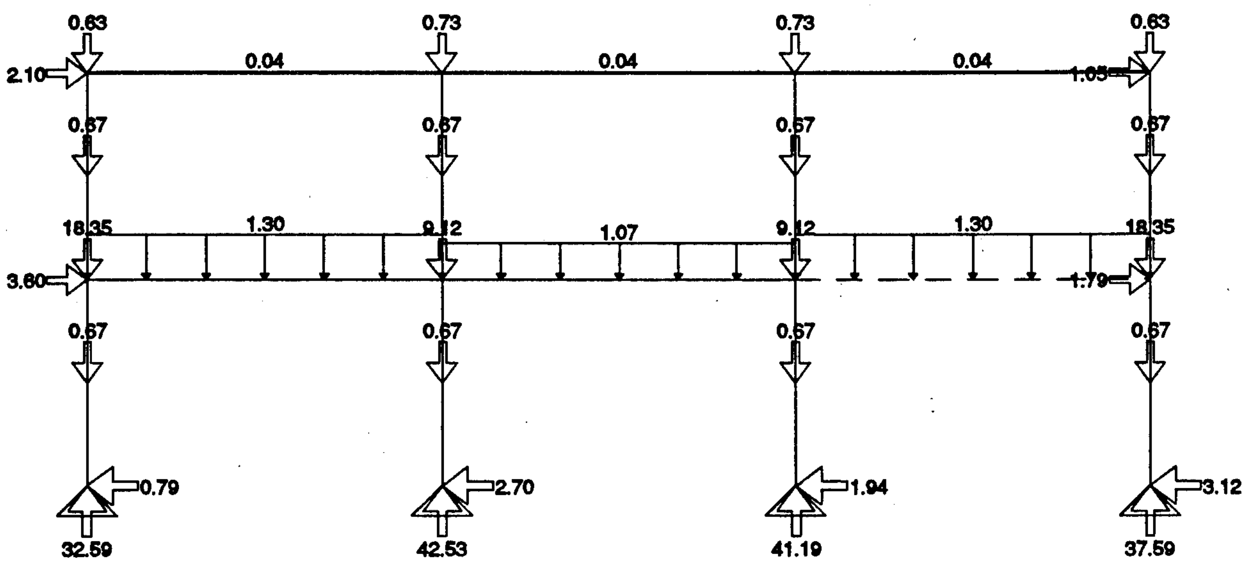
Total Combined Load: D + W -- Shear (k)



Total Combined Load: D + W -- Moment (ft-k)



Total Combined Load: D + W -- Deflection



Total Combined Load: D + W -- Loads & Reactions (k)

Project : Office Building - Scheme A
Location : Radford AAP
Time : Wed Aug 31, 1994 1:09 PM

****************** Rigid Horizontal Diaphragm Calculations *****************

Center of Rigidity

Name	h (ft)	I (ft^4)	Av (sqft)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
NS-1	14.0	0	0	100.834	0.010	32.48%	0.8	0.008
NS-2	14.0	0	0	100.834	0.010	32.48%	48.8	0.484
NS-3	14.0	0	0	93.487	0.011	35.04%	84.8	0.907
Sum					0.031			1.400

Centroid from lower left = sum(R*x)/sum(R) : 45.85 ft
Maximum rigid diaphragm dimension : 85.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 3.02 ft

Name	h (ft)	I (ft^4)	Av (sqft)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
EW-1	14.0	0	0	78.168	0.013	50.00%	72.8	0.932
EW-2	14.0	0	0	78.168	0.013	50.00%	0.8	0.011
Sum					0.026			0.942

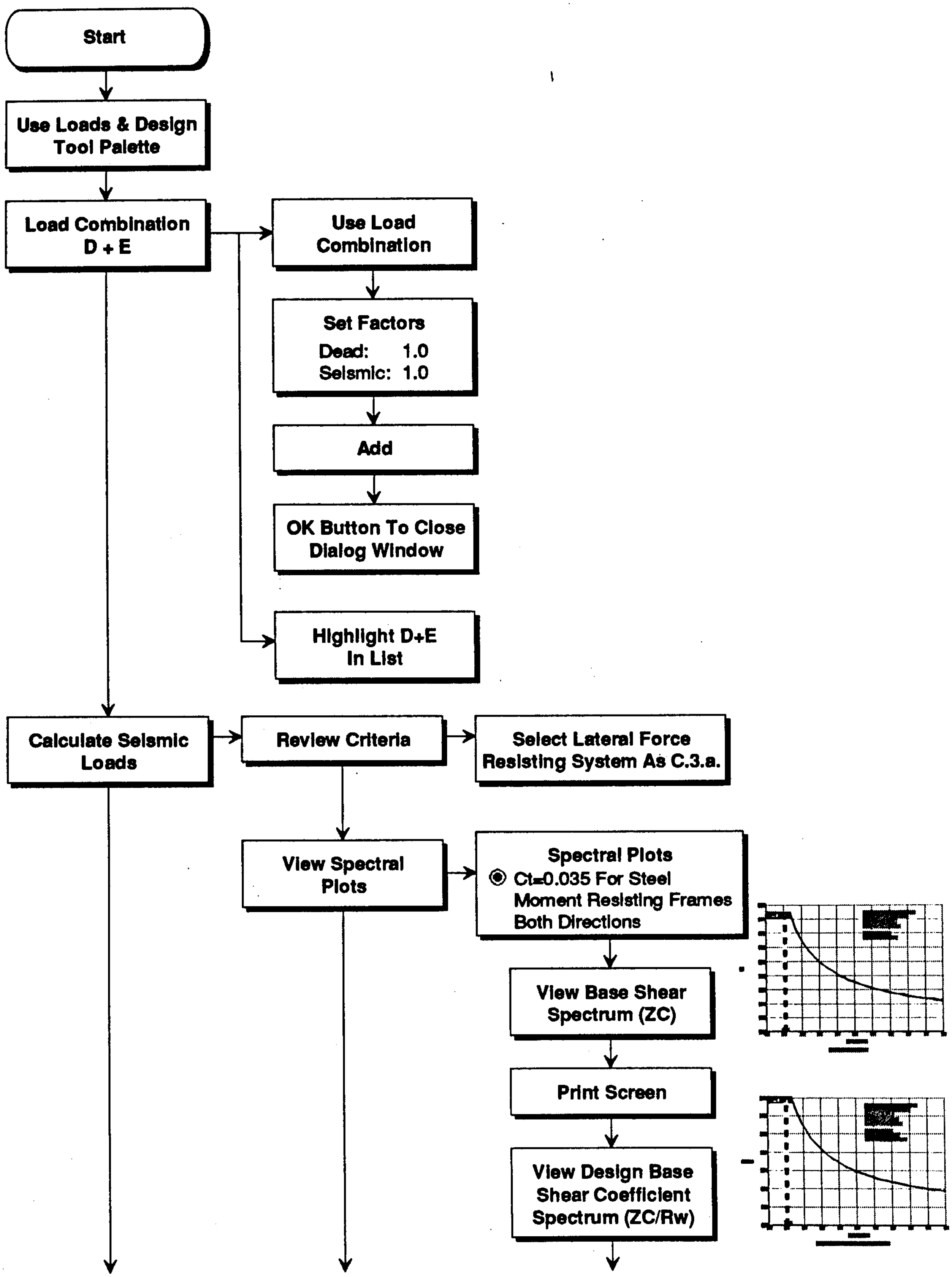
Centroid from lower left = sum(R*x)/sum(R) : 36.83 ft
Maximum rigid diaphragm dimension : 73.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 0.00 ft

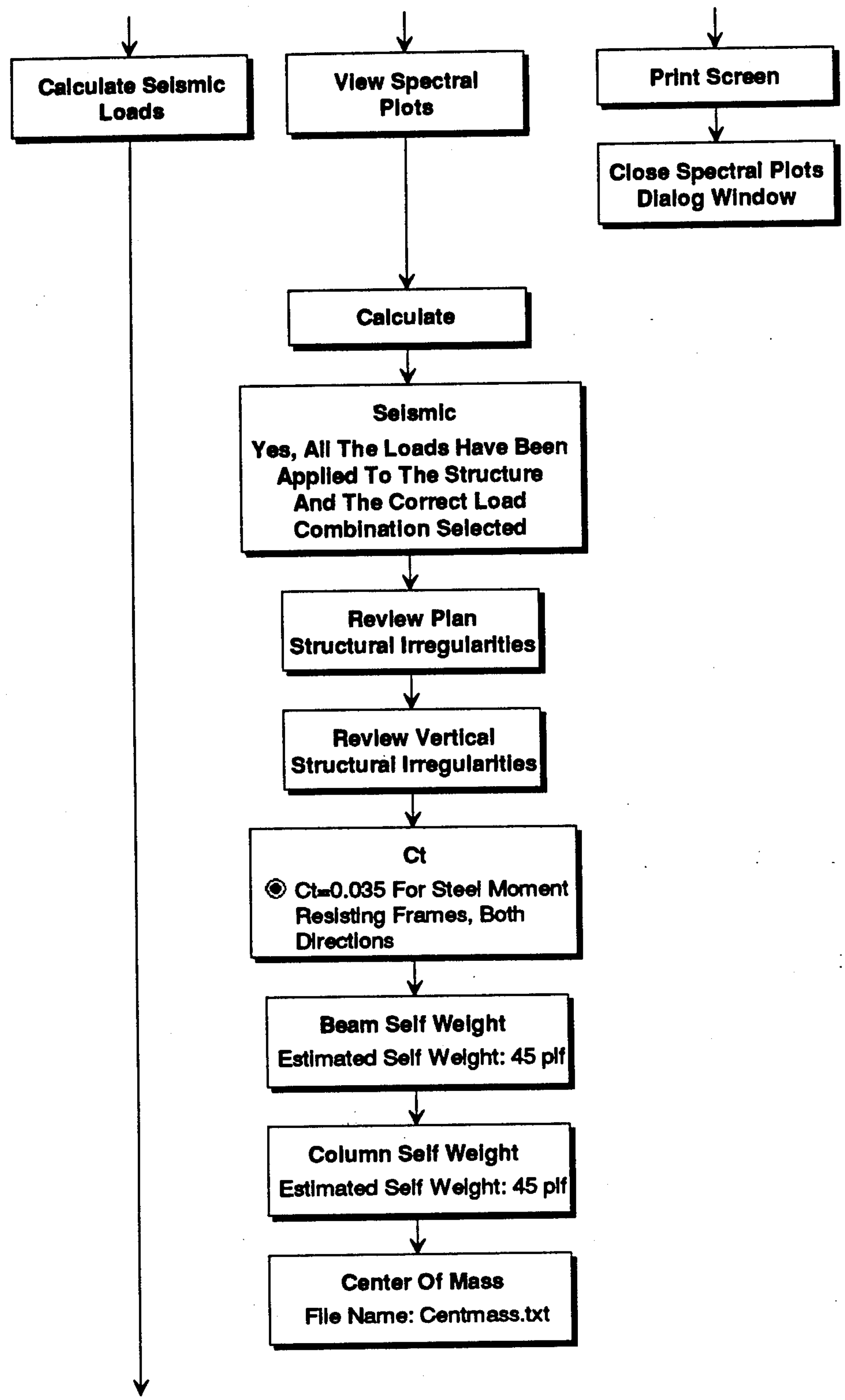
Assumptions used:
Deflections calculated by applying a 1000 k load.

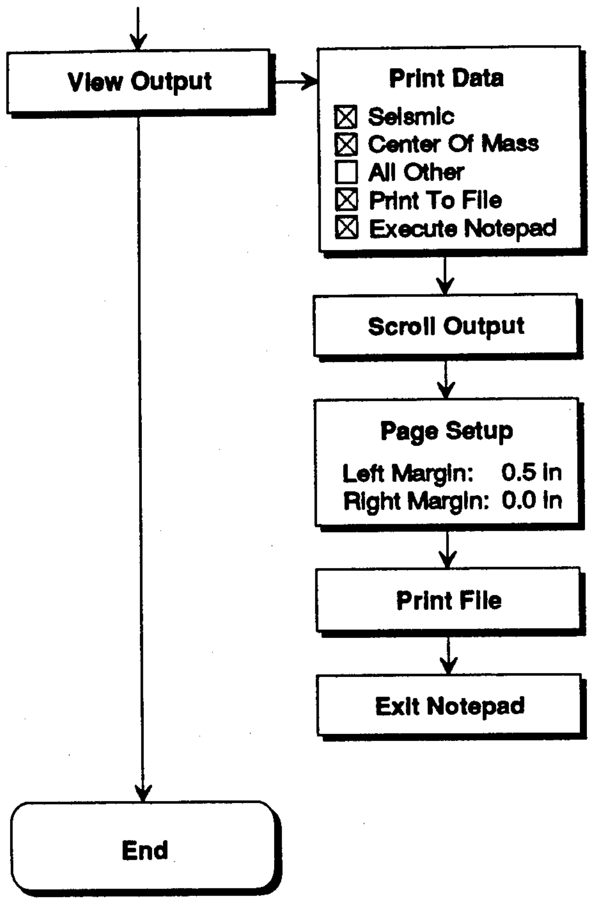
Name	h (ft)	Rigidity	dx (ft)	R*dx	R*dx*dx	R*dx/ sum(R*dx*dx)
NS-1	14.0	0.010	45.0	0.446	20.101	0.00641
NS-2	14.0	0.010	3.0	0.030	0.088	0.00042
NS-3	14.0	0.011	39.0	0.417	16.252	0.00599
EW-1	14.0	0.013	36.0	0.461	16.580	0.00662
EW-2	14.0	0.013	36.0	0.461	16.580	0.00662
Sum					69.601	

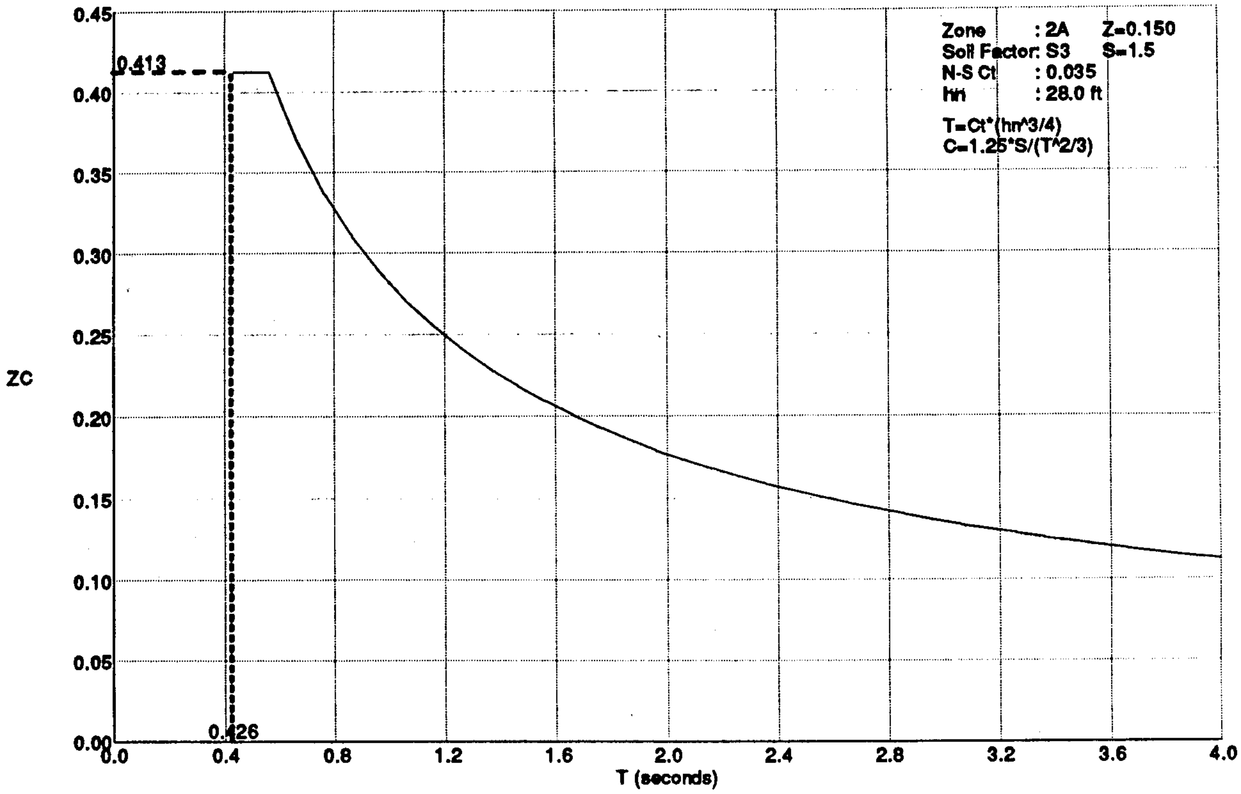
Shear distribution : Fv = V*R/sum(R)
Torsional moment : Mt = V*e
Torsional component : Ft = Mt*R*dx/sum(R*dx*dx)
Total shear to element: Ftotal = Fv + Ft

Seismic Loads

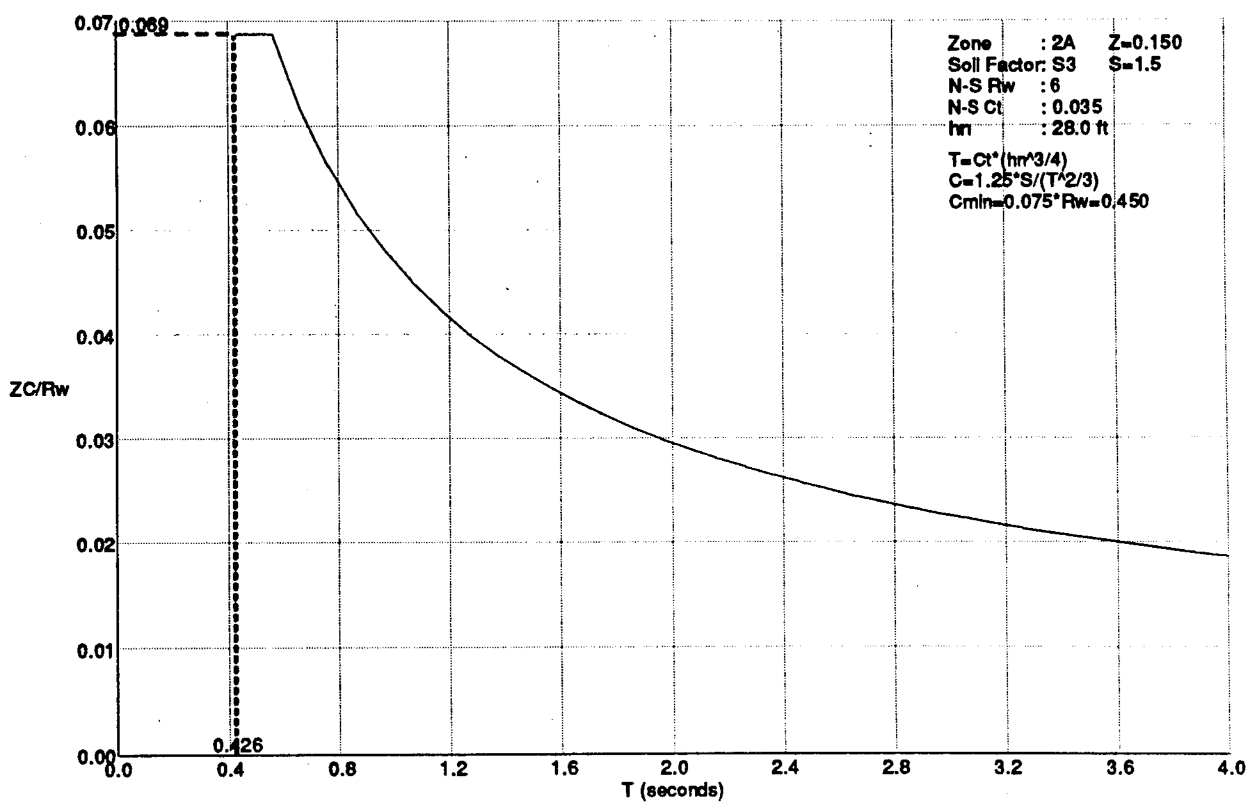



Calculate Seismic Loads
View Spectral Plots
Print Screen
Close Spectral Plots Dialog Window
Calculate
Seismic
Yes, All The Loads Have Been Applied To The Structure And The Correct Load Combination Selected
Review Plan Structural Irregularities
Review Vertical Structural Irregularities
Ct
Ct=0.035 For Steel Moment Resisting Frames, Both Directions
Beam Self Weight
Estimated Self Weight: 45 plf
Column Self Weight
Estimated Self Weight: 45 plf
Center Of Mass
File Name: Centmass.txt


View Output
Print Data
☒ Seismic
☒ Center Of Mass
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End



N-S Base Shear Spectrum



N-S Design Base Shear Coefficient Spectrum

```
Project      : Office Building - Scheme A
Location     : Radford AAP
Seismic Code: TM 5-809-10 1992
Time         : Wed Aug 31, 1994   2:28 PM

**************************** Seismic Analysis *****************************

 3. Upper Roof                                    :    194.9 k
 2. Second Floor/Lower Roof                       :    686.9 k
----------------------------------------------------------
Total Building Weight (W)                         :    881.7 k

***************************** N - S and E - W ******************************

Zone: 2A: Z = 0.150
Importance Category: IV: I = 1.00
Soil Factor: S3: S = 1.5
System: C3a: Rw = 6
Ct = 0.035
hn = 28.0 ft
T = Ct*hn^3/4 = 0.426 sec
C = 1.25*S/T^2/3 = 3.31 > 2.75
C = 2.75
C/Rw = 0.458 > 0.075
W = 881.7 k
V = Z*I*C*W/Rw
+-------------------------+
|       V = 60.6 k        |
+-------------------------+

T < 0.7 sec
+-------------------------+
|       Ft = 0.0 k        |
+-------------------------+

+-------------------------+
|     V-Ft = 60.6 k       |
+-------------------------+

            Floor to                           w*h/                sum(F)
Level   h   Floor h    w    sum(w)      w*h   sum(w*h)       F        V
      (ft)   (ft)     (k)     (k)     (kft)                 (k)      (k)
-----------------------------------------------------------------------
                                                 Ft =        0.0
  3   28.0            195               5457   0.362        21.9
             14.0             195                                    21.9
  2   14.0            687               9616   0.638        38.7
             14.0             882                                    60.6
  1    0.0
-----------------------------------------------------------------------
Sum                   882              15073   1.000        60.6

            Floor to                  sum(F)                        Ft+sum(F)/
Level   h   Floor h    w    sum(w)      V      OTM    sum(OTM)       sum(w)
      (ft)   (ft)     (k)     (k)      (k)    (kft)    (kft)
--------------------------------------------------------------------------
  3   28.0            195
             14.0             195      21.9    307                    0.113
  2   14.0            687                              307
             14.0             882      60.6    849                    0.069
  1    0.0                                            1156
--------------------------------------------------------------------------
Sum                   882                     1156
```

Project : Office Building - Scheme A
Location : Radford AAP
Time : Wed Aug 31, 1994 2:28 PM

****************************** Center Of Mass ******************************

Upper Roof -- 28.00 ft

Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Exterior Wall	36.9	36.8	1358.9	0.8	30.7
Exterior Wall	24.6	0.8	20.5	24.8	610.8
Exterior Wall	36.9	36.8	1358.9	48.8	1801.6
Exterior Wall	24.6	72.8	1791.4	24.8	610.8
Upper Roof	49.8	36.8	1833.1	24.8	1235.9
Beam Self Weight	18.4	36.8	676.3	24.8	455.9
Column Self Weight	3.8	36.8	139.2	24.8	93.9
Sum	194.9		7178.2		4839.6

N-S Center Of Mass: 36.83 ft
E-W Center Of Mass: 24.83 ft

Second Floor/Lower Roof -- 14.00 ft

Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Second Floor	72.9	12.8	935.1	24.8	1809.5
Second Floor	60.7	36.8	2236.5	28.8	1750.8
Second Floor	72.9	60.8	4432.6	24.8	1809.5
Lower Roof	123.6	36.8	4554.0	66.8	8263.2
Exterior Wall	73.8	36.8	2717.8	0.8	61.5
Exterior Wall	24.6	0.8	20.5	24.8	610.8
Exterior Wall	36.9	36.8	1358.9	48.8	1801.6
Exterior Wall	24.6	72.8	1791.4	24.8	610.8
Parapet	9.9	0.8	8.3	66.8	662.1
Parapet	19.8	36.8	729.8	84.8	1680.9
Parapet	9.9	72.8	721.6	66.8	662.1
Beam Self Weight	24.8	36.8	914.9	36.2	899.9
Column Self Weight	5.7	36.8	208.8	36.2	205.4
Exterior Wall	43.0	0.8	35.9	42.8	1843.6
Exterior Wall	36.9	36.8	1358.9	84.8	3129.7
Exterior Wall	43.0	72.8	3134.9	42.8	1843.6
Column Self Weight	3.8	36.8	139.2	24.8	93.9
Sum	686.9		25299.0		27738.8

N-S Center Of Mass: 36.83 ft
E-W Center Of Mass: 40.39 ft

Seismic Lateral Analysis

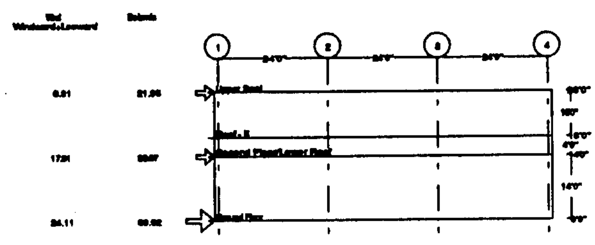
Start

Use Loads & Design Tool Palette

Define Member Properties → See Wind Lateral Analysis

Select Second Floor/ Lower Roof Horizontal Structural Plane

Compare Wind & Seismic Loads → Use Compare Wind & Seismic: N-S Building Levels → Compare Wind & Seismic



Load Combination D + E → Use Load Combination → Set Factors Dead: 1.0 Seismic: 1.0 → Add → OK Button To Close Dialog Window

→ Highlight D+E In List

Lateral Analysis → Use Lateral Resistance Design

Lateral Analysis

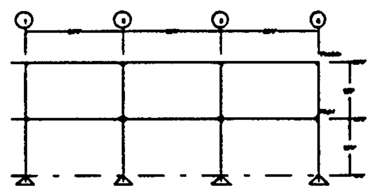
Select NS-1

Analysis
Units: Feet & Kips
Load Combination: D+E
☒ Use Actual Properties
☐ DL=Deck+Self Weight

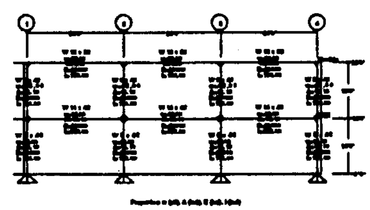
Connectivity
◉ Hinge

Repeat For All Supports

Lateral Resistance Verify All Rigid Connections

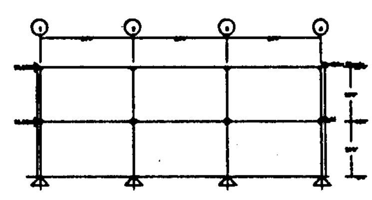


Yes, Properties Are All Correct



Flexible Diaphragm
◉ Simple Beam Model

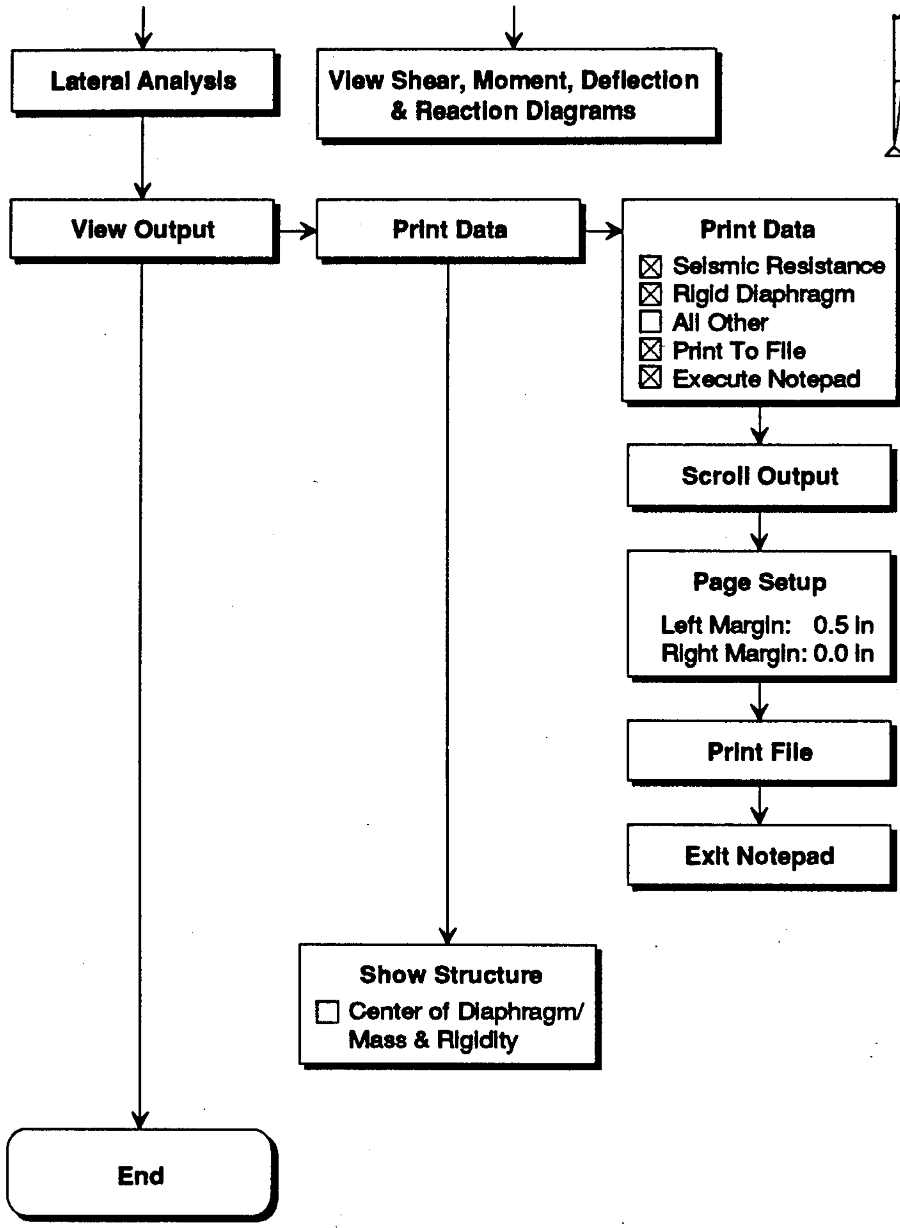
Rigid Horizontal Diaphragm Calculations
File Name: Rigidout.txt
☐ Enter Deflections At Each Level

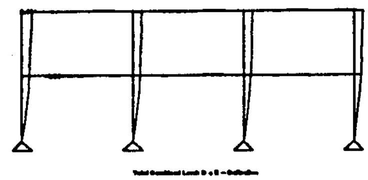


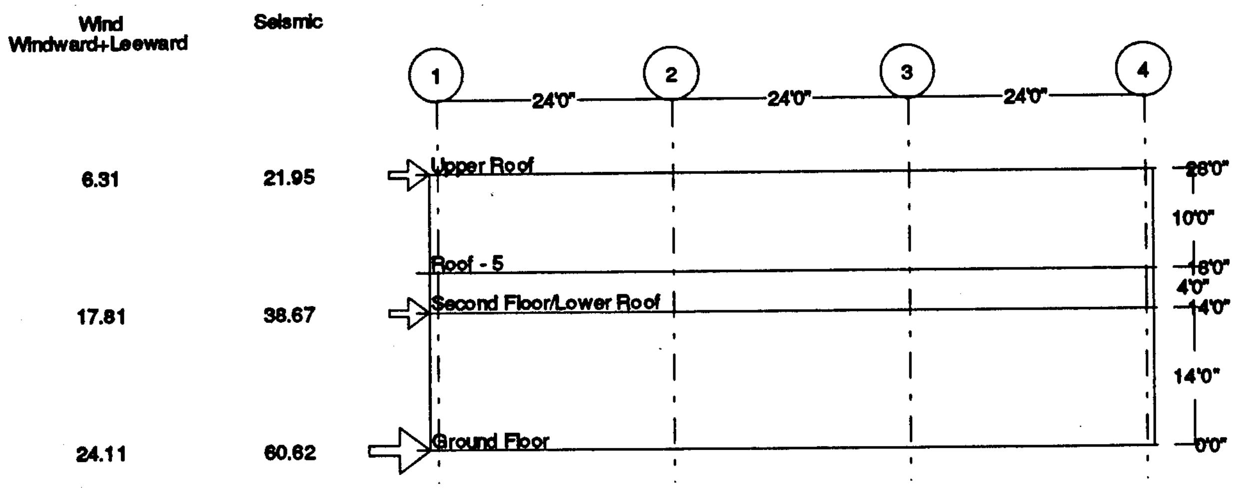
View Loads

Seismic Lateral Resistance Locations
File Name: Latseis.txt

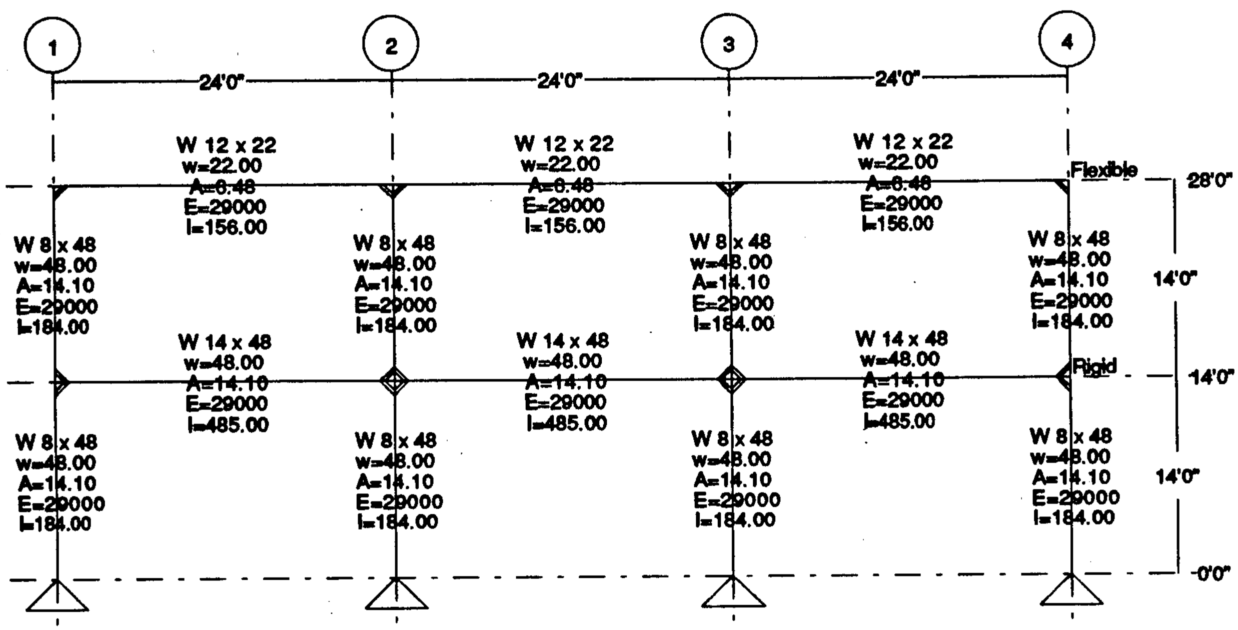
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct


Lateral Analysis
View Shear, Moment, Deflection & Reaction Diagrams
View Output
Print Data
Print Data
☒ Seismic Resistance
☒ Rigid Diaphragm
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
Show Structure
☐ Center of Diaphragm/ Mass & Rigidity
End

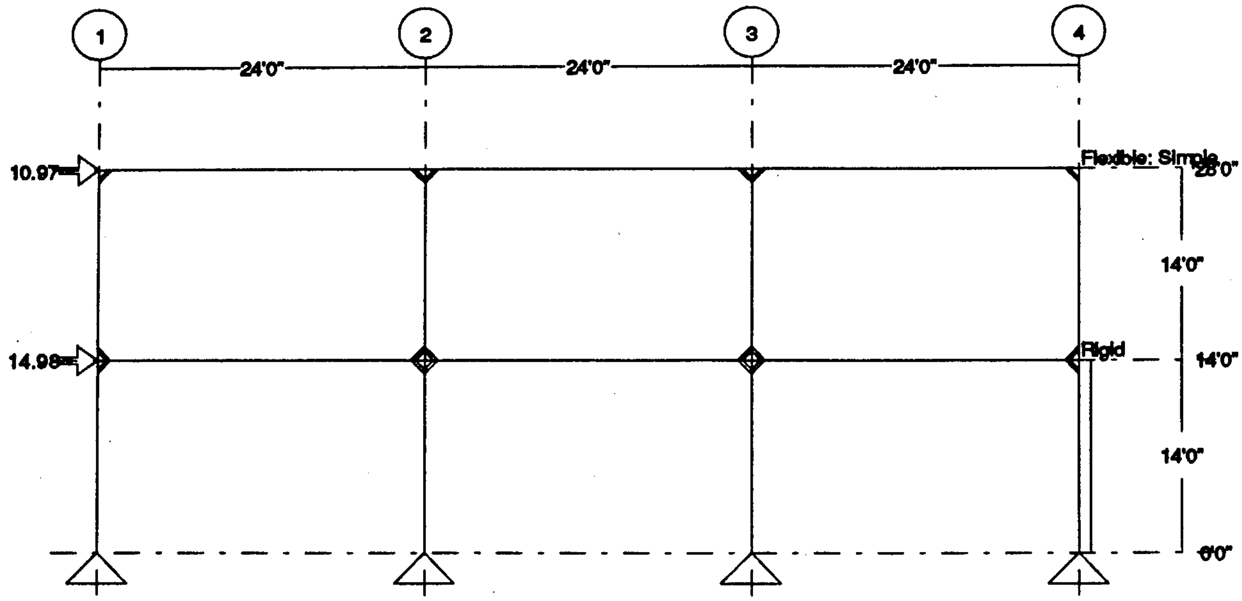




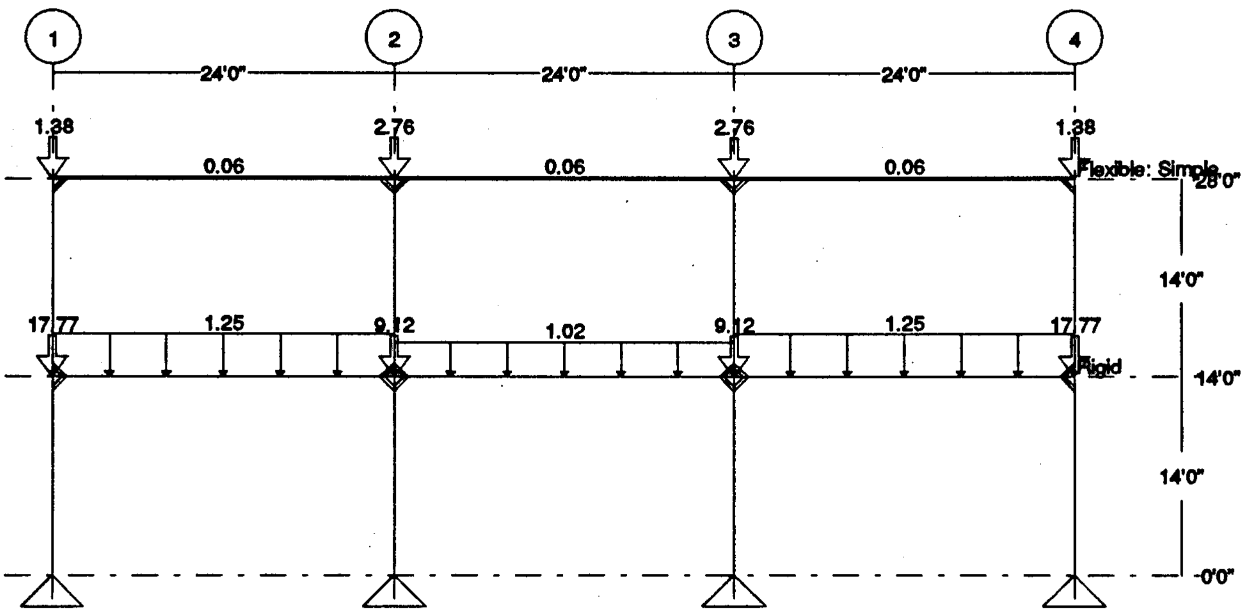
Compare Wind & Seismic Loads -- N-S Building Levels (k)



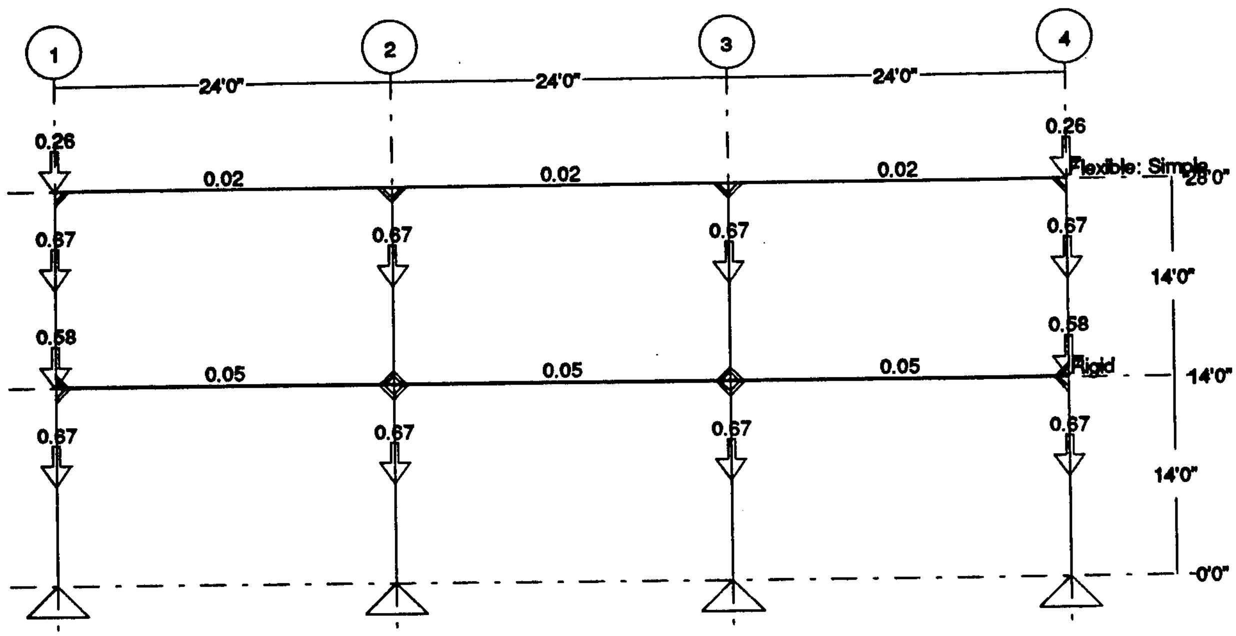
Properties: w (plf), A (in2), E (ksi), I (in4)



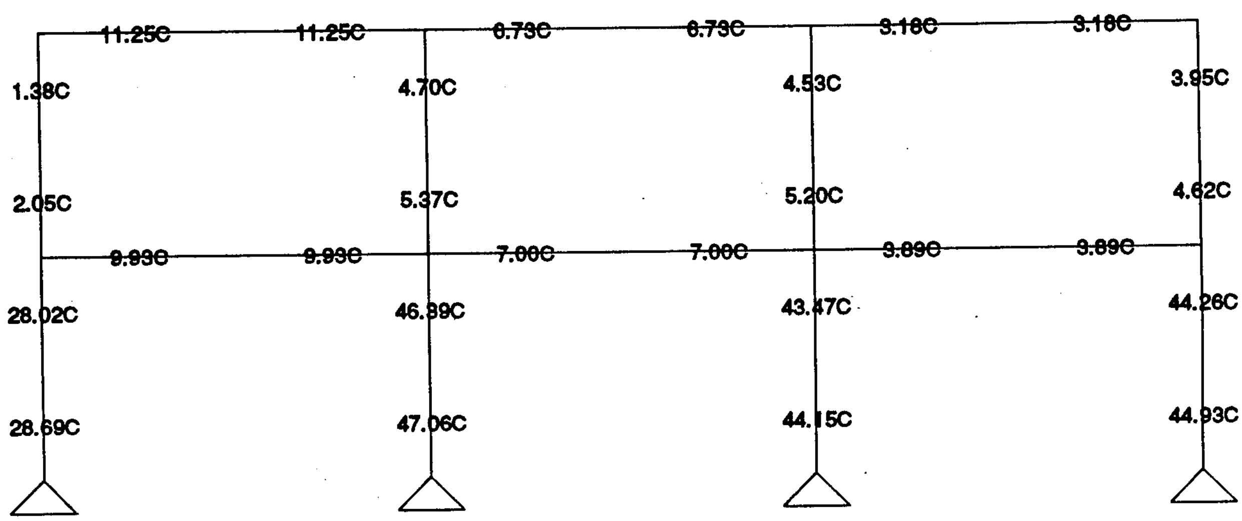
1.00 Seismic (klf) -- NS-1 -- F, 32%



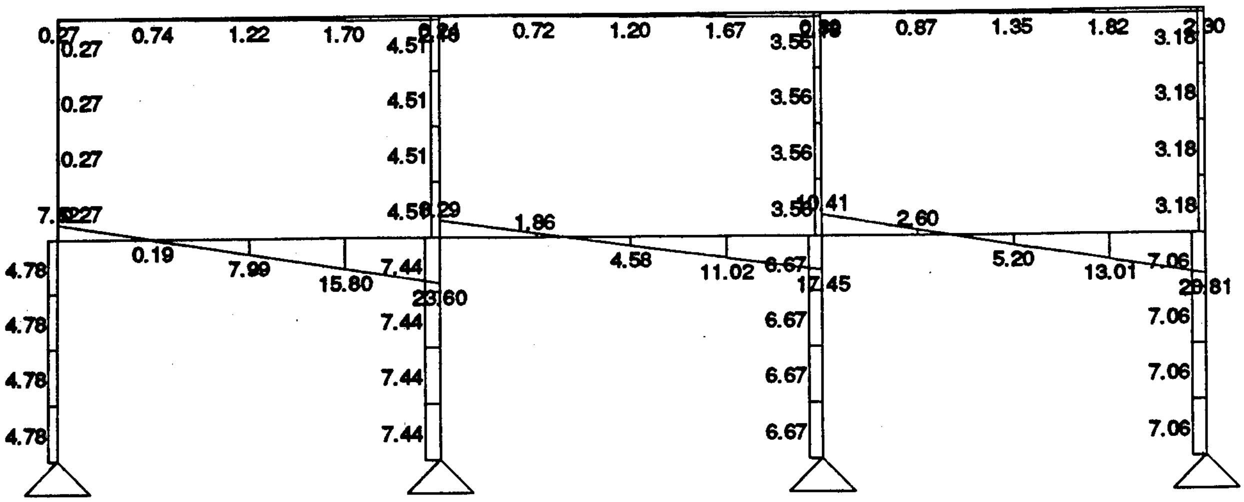
1.00 Superimposed Dead (klf) -- NS-1



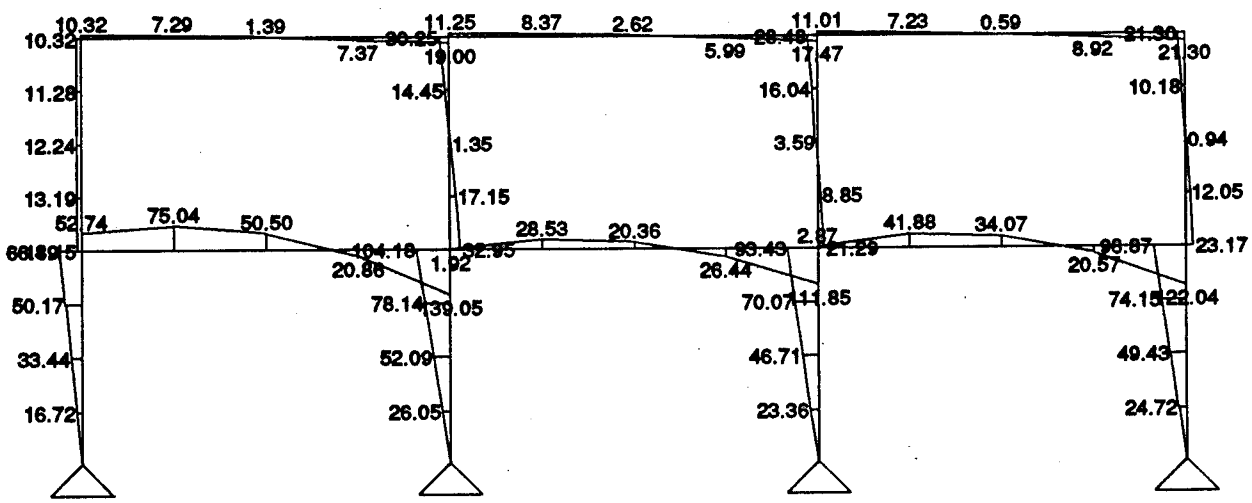
1.00 Dead (klf) -- NS-1



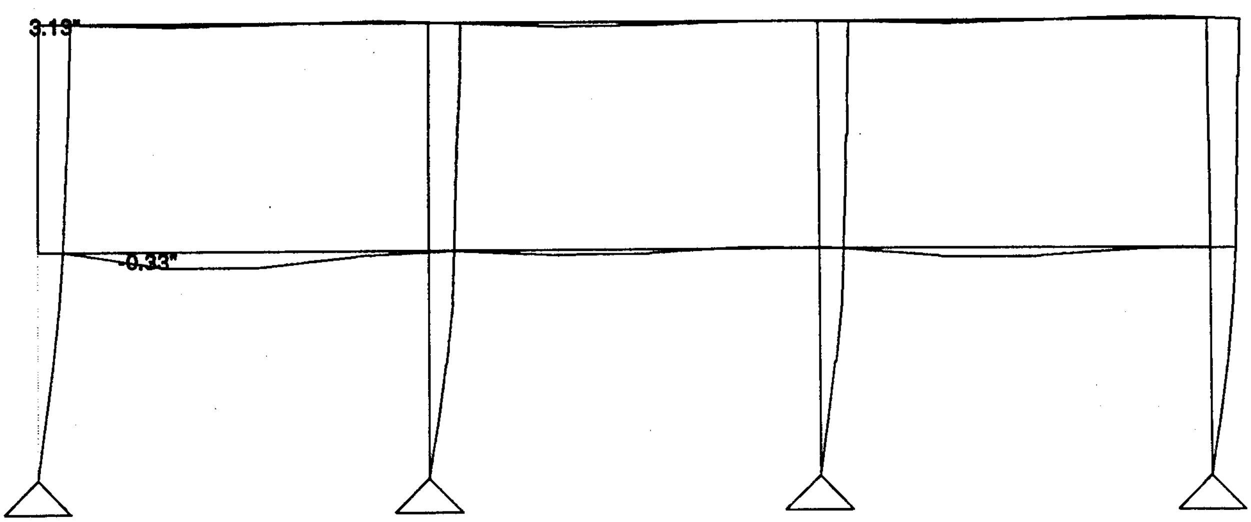
Total Combined Load: D + E -- Axial (k)



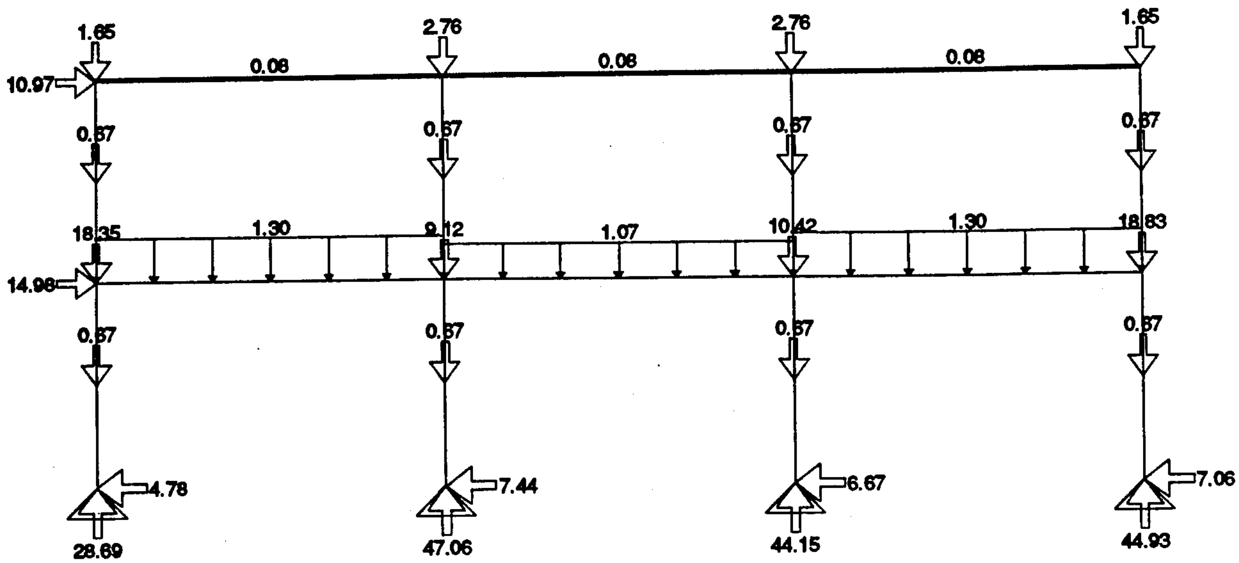
Total Combined Load: D + E – Shear (k)



Total Combined Load: D + E – Moment (ft-k)



Total Combined Load: D + E -- Deflection



Total Combined Load: D + E -- Loads & Reactions (k)

Project : Office Building - Scheme A
Location : Radford AAP
Seismic Code: TM 5-809-10 1991
Time : Sun Jan 26, 1992 1:43 PM

****************** Seismic Lateral Resistance Locations *******************

NS-1 -- F, 32%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		21.9			
		14.0		21.9	307	
2	14.0		38.7			307
		14.0		60.6	849	
1	0.0					1156
Sum			60.6		1156	

NS-2 -- F, 32%

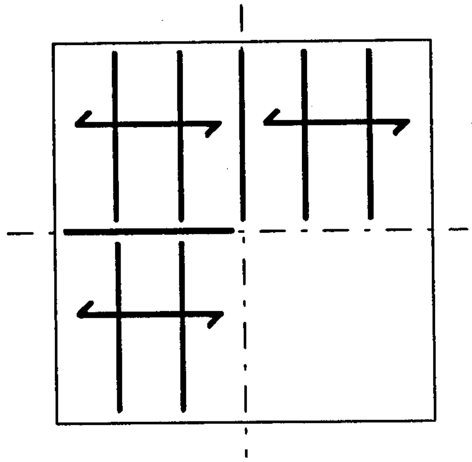
Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		21.9			
		14.0		21.9	307	
2	14.0		38.7			307
		14.0		60.6	849	
1	0.0					1156
Sum			60.6		1156	

NS-3 -- F, 35%						
Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
2	14.0		38.7			
		14.0		38.7	541	
1	0.0					541
Sum			38.7		541	

Quantity Take-Off Philosophy

3 Considerations

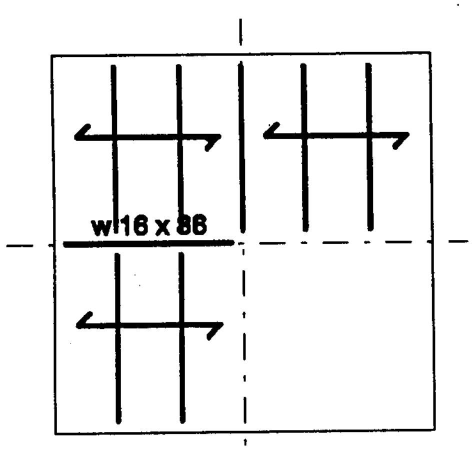
1. One typical interior bay (exterior side bay, corner bay)



2 bays
by
2 bays

2. One typical floor level and roof level

3. The entire building structural system



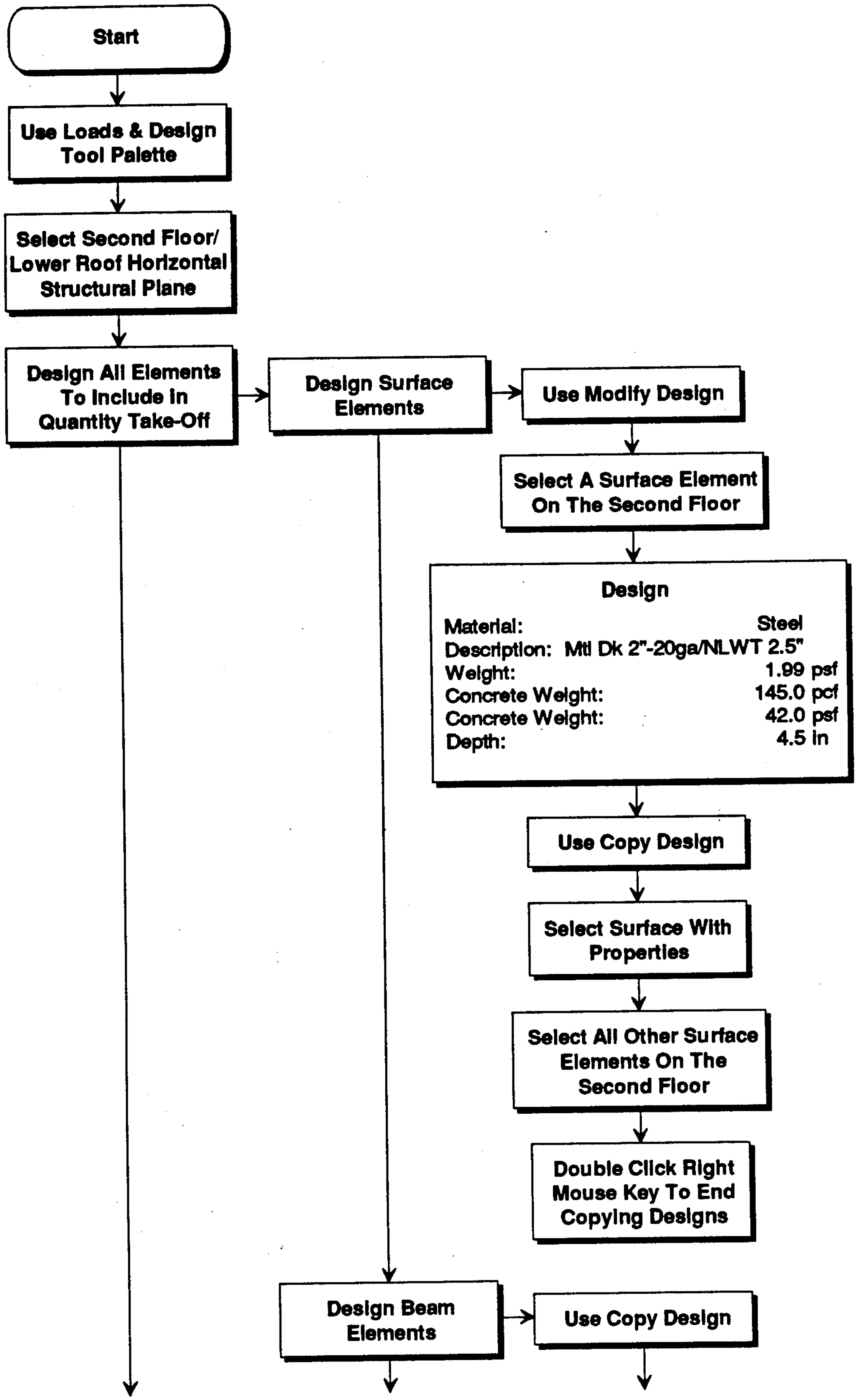
Estimated weights are not used for quantity take-offs

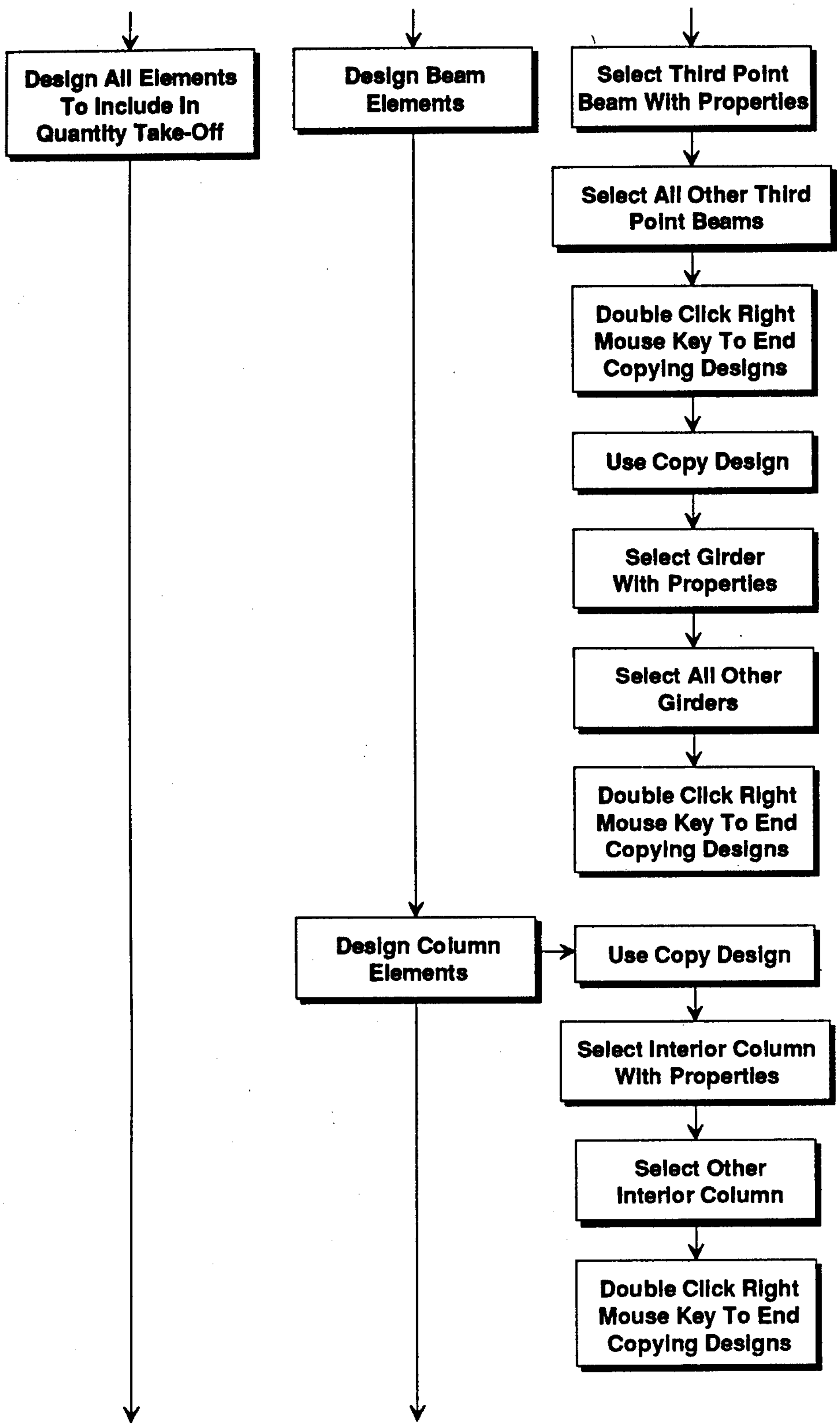
Elements designed by Excel spreadsheets are used

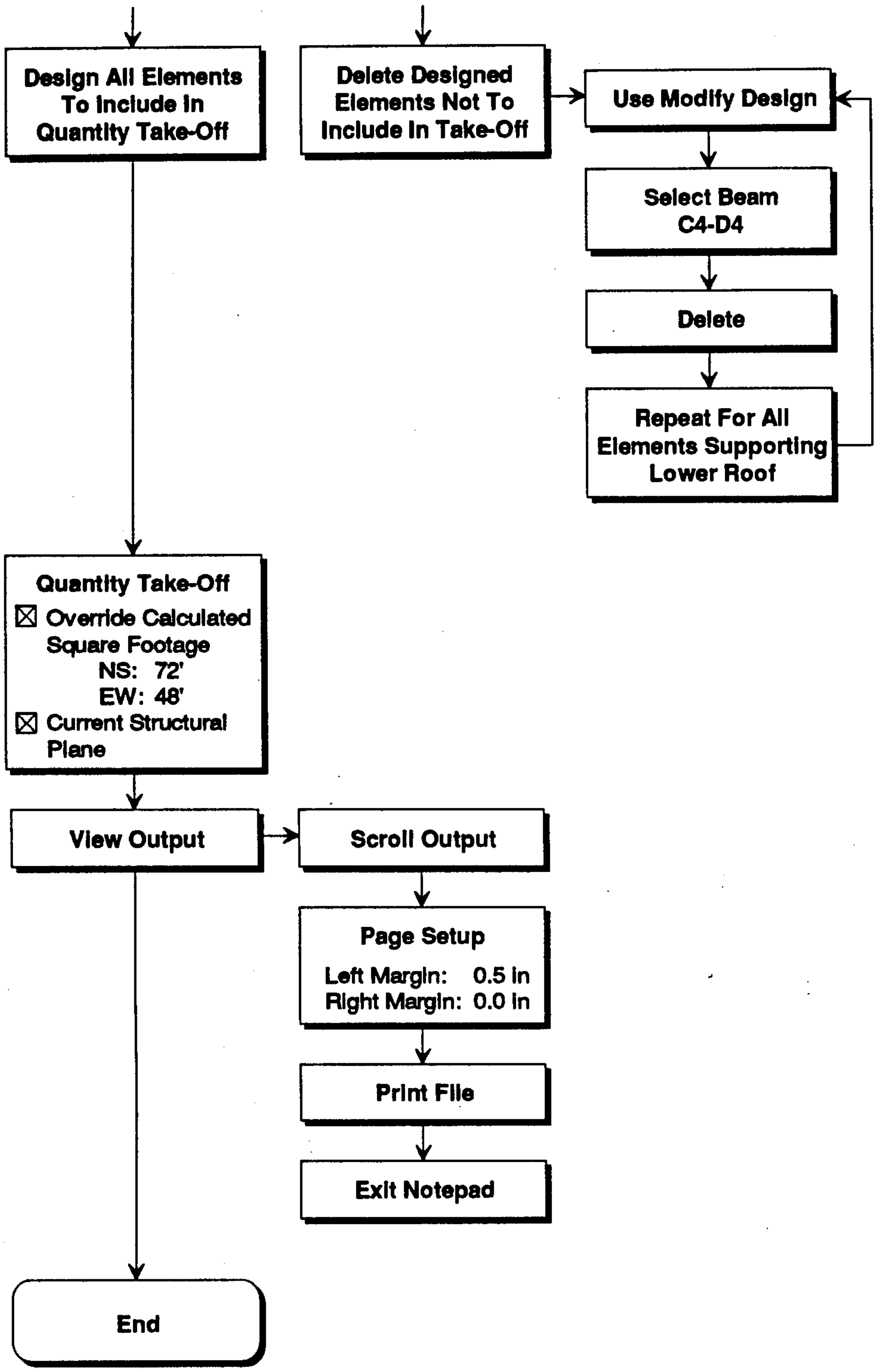
Use Modify Design and Copy Design to manually enter element sizes

Calculated square footage can be overridden

Quantity Take-Off




Design All Elements To Include In Quantity Take-Off
Design Beam Elements
Select Third Point Beam With Properties
Select All Other Third Point Beams
Double Click Right Mouse Key To End Copying Designs
Use Copy Design
Select Girder With Properties
Select All Other Girders
Double Click Right Mouse Key To End Copying Designs
Design Column Elements
Use Copy Design
Select Interior Column With Properties
Select Other Interior Column
Double Click Right Mouse Key To End Copying Designs


Design All Elements To Include In Quantity Take-Off
Delete Designed Elements Not To Include In Take-Off
Use Modify Design
Select Beam C4-D4
Delete
Repeat For All Elements Supporting Lower Roof
Quantity Take-Off
☒ Override Calculated Square Footage
NS: 72'
EW: 48'
☒ Current Structural Plane
View Output
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Project : Office Building - Scheme A
Location : Radford AAP
Time : Sun Jan 26, 1992 1:57 PM

***************************** Quantity Take-off ****************************

Second Floor/Lower Roof

Plan Area: 72.0 ft x 48.0 ft: 3456.0 sqft

STEEL: Narrowly Spaced Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
	24.0	0.0	0.0	24	0
Sum					0

Total Weight : 0.0 tons
Weight Per Square Foot : 0.0 psf

STEEL: Widely Spaced Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
W 14 x 48	24.0	48.0	1152.0	10	11520
	18.0	0.0	0.0	4	0
W 21 x 68	24.0	68.0	1632.0	4	6528
W 16 x 40	24.0	40.0	960.0	15	14400
	24.0	0.0	0.0	3	0
Sum					32448

Total Weight : 16.2 tons
Weight Per Square Foot : 9.4 psf

STEEL: Surface Elements

Description	Total Depth (in)	Area (sqft)	Weight (psf)	Conc Weight (pcf)	Conc Weight (psf)	Total (lbs)	Weight Conc (lbs)
Mtl Dk 2"-20ga/NLWT 2.5"	4.5	2880	2.0	145.0	42.0	5731	120960
Mtl Dk 2"-20ga/NLWT 2.5"	4.5	384	2.0	145.0	42.0	764	16128
	0.0	2592	0.0	0.0	0.0	0	0
Sum						6495	137088

Concrete Cubic Yards : 35.0
Total Weight : 3.2 tons

STEEL: Column Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
W 8 x 48	14.0	48.0	672.0	10	6720
W 8 x 28	14.0	28.0	392.0	2	784
	14.0	0.0	0.0	6	0
Sum					7504

Total Weight : 3.8 tons
Weight Per Square Foot : 2.2 psf

Concluding Remarks

Schemes A, B and C were developed to permit exploration and instruction of the broadest possible range of CASM capabilities. The schemes should not be viewed as completely logical structural framing solutions to the given design parameters, nor as necessarily economical. Each of the three schemes contain a variety of elements, which if properly combined and interchanged might produce "real" schemes for consideration at a 35% review.

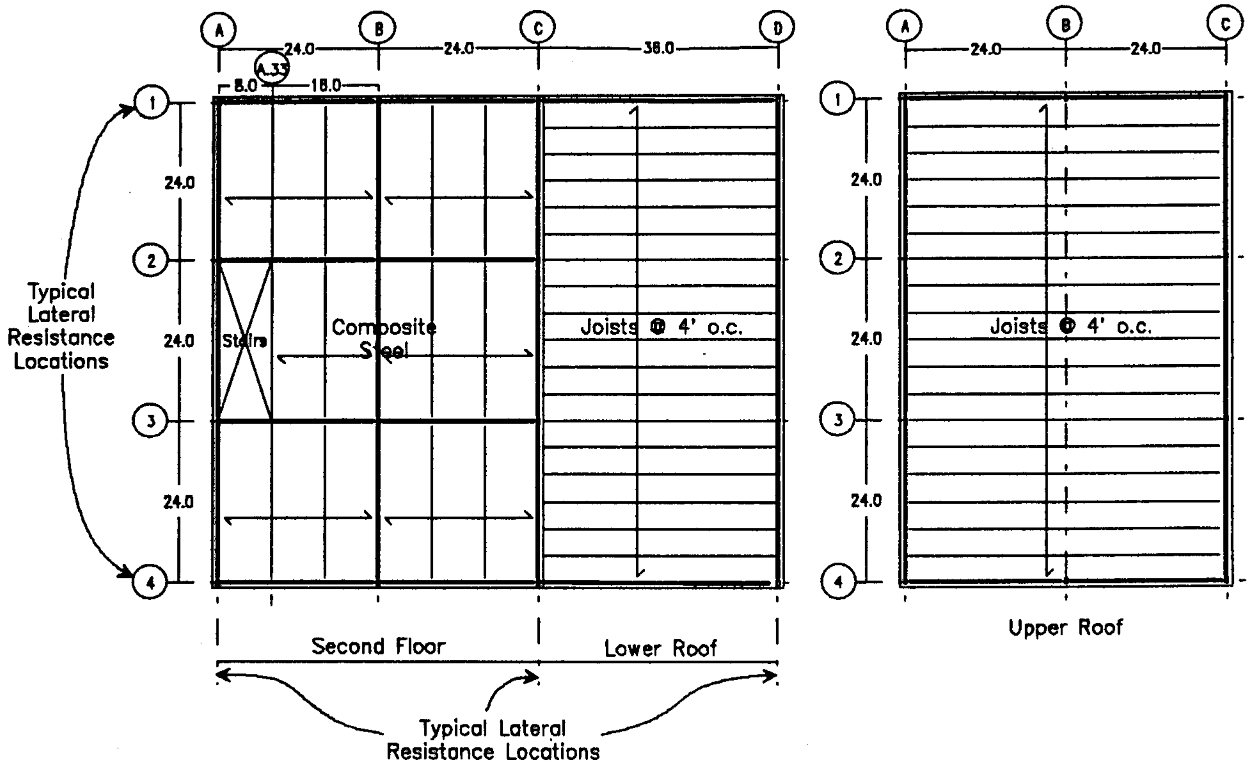
Examples of unlikely components assembled in schemes A, B and C include: (1) concrete as a decking for the low roof, (2) custom made trusses for the low roof framing, (3) prefabricated limestone wall panels mixed with cast-in-place concrete shear walls, and (4) non-composite steel beam framing for the second floor.

A logical **steel framed beam/column** solution for "real" consideration would include open web steel joists spanning 48 feet for the upper roof to eliminate a central column in the second floor space. The lower roof would be framed with 36 foot span open web steel joists (without inclusion of custom trusses) as in scheme B. Both roofs would be sheathed with a metal roof deck without concrete and both would become flexible diaphragms. The second floor would be framed with composite steel beams as in scheme B and remain a rigid diaphragm. Two lateral load resistance system options could be compared. One scheme could include a moment resistant frame approach similar to scheme A, while a second approach might incorporate trussing similar to scheme B. The non-loadbearing exterior envelope is open to a variety of possibilities. The Architects will likely dictate the aesthetic expression. The foundation system would be a combination of isolated and linear spread footings.

A third logical solution would be a **masonry bearing wall** system to support the steel open-web joist roof planes described above. The second floor plane might be constructed of pre-cast pre-stressed hollow cored planks, which would also bear on the walls and a central steel girder line. Some of these walls could become shear walls for lateral load resistance. Thus the exterior envelope and the interior partition provide a structural function, eliminating costly moment connections and columns within the exterior wall layout. Footings are now all linear spread footings with only one isolated footing.

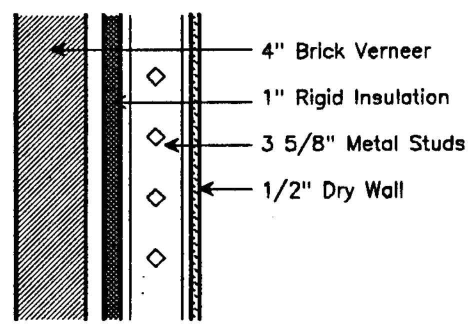
It is unlikely that a reinforced concrete frame would present an economical solution for a 1-2 story office building.

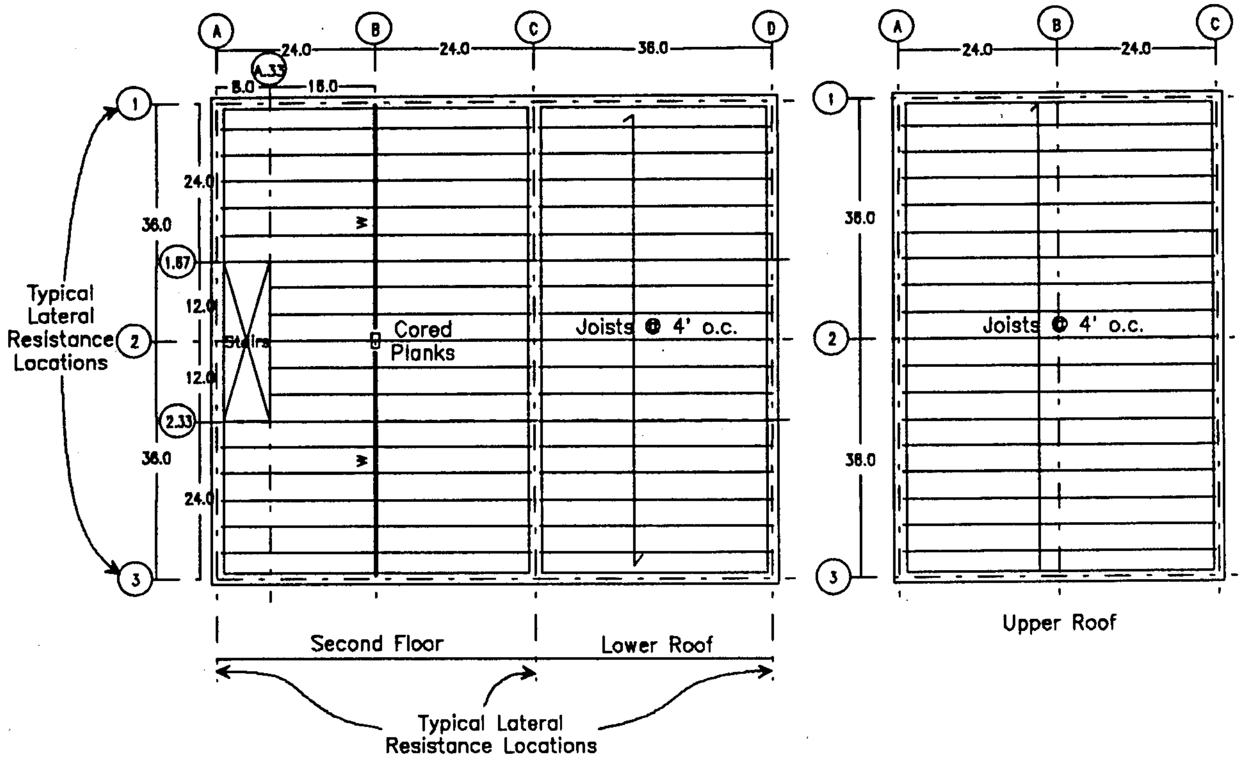
The structural engineers that become proficient with the use of CASM will be able to explore many other ideas to arrive at the most structurally efficient and economical solution for this hypothetical project.



Scheme 1: Moment connections for lateral load resistance

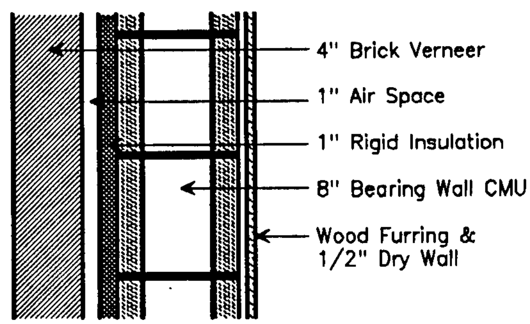
Scheme 2: Trussing for lateral load resistance





Scheme 3: Shear walls for lateral load resistance

8" CMU walls can be used as shear walls



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13.ABSTRACT *(Maximum 200 words)*

The Computer-Aided Structural Modeling (CASM) computer program is designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional (3-D) interactive graphics. CASM allows the structural engineer to quickly evaluate various framing alternatives in order to make more informed decisions in the initial structural evaluation process. The program was developed by the Information Technology Laboratory in conjunction with the Computer-Aided Structural Engineering (CASE) Project, Building Systems Task Group.

This release of the CASM is designed to aid the user with design criteria, building loads, and structural framing and design. The various parts of the program are summarized below.

a. Basic design criteria. The user can enter information directly or retrieve information from a user-definable database. The design criteria include information about the project, regional design information, and site-specific design information.

b. Building geometry. The user can assemble the building shape using 3-D primitives (cubes, prisms, spheres, cylinders, etc.) in an easy manner using pull-down menus, icons, and a mouse.

(Continued)

14.SUBJECT TERMS

Building systems	Preliminary structural design
Computer-Aided Structural Engineering (CASE)	Structural modeling
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Computer programs	3-Dimensional loads

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c. Dead and live loads. The user can select and construct dead and live loads from several user-definable menus of building materials and load conditions. These loads can then be applied to any desired area of the building volume.

d. Snow and wind loads. These loads are automatically calculated in 3-D using information from the basic design criteria database. Wind loads are also calculated for components and cladding and open roof structures. These loads are calculated in accordance with TM 5-809-1.

e. Seismic loads. These loads are calculated based on the equivalent static force method presented in TM 5-809-10.

f. Structural layout. The engineer can easily and rapidly experiment with various framing schemes inside the defined building volume. Beams, girders, joists, girts, columns, walls, and custom trusses are some of the structural elements that can be modeled.

g. Member analysis and preliminary sizing. The user can apply loads to the building geometry from a list of user-defined load cases. The shear, moment, and deflection of selected members may be calculated for various loading conditions (including pattern loads) and connectivity (including continuous beams). The design of a member is performed using a spreadsheet.

Data from the various investigated framing schemes can be edited and printed by CASM and used as justification in a design document.

This report presents Scheme A, all steel, noncomposite, lateral load resistance for rigid frames.

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	Title	Date
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Technical Report K-80-1	Survey of Bridge-Oriented Design Software	Jan 1980
Technical Report K-80-2	Evaluation of Computer Programs for the Design/Analysis of Highway and Railway Bridges	Jan 1980
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Instruction Report K-80-3	A Three-Dimensional Finite Element Data Edit Program	Mar 1980
Instruction Report K-80-4	A Three-Dimensional Stability Analysis/Design Program (3DSAD)	
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	Report 3: General Analysis Module (CGAM)	Jun 1982
	Report 4: Special-Purpose Modules for Dams (CDAMS)	Aug 1983
Instruction Report K-80-6	Basic User's Guide: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
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Technical Report K-83-3	Reference Manual: Computer Graphics Program for Generation of Engineering Geometry (SKETCH)	Sep 1983
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Technical Report ITL-87-2	A Case Committee Study of Finite Element Analysis of Concrete Flat Slabs	Jan 1987
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Instruction Report GL-87-1	User's Guide: UTEXAS3 Slope-Stability Package; Volume IV, User's Manual	Nov 1992
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Instruction Report ITL-94-5	User's Guide: Computer Program for Winkler Soil-Structure Interaction Analysis of Sheet-Pile Walls (CWALSSI)	Nov 1994
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Instruction Report ITL-94-7	User's Guide to CTWALL – A Microcomputer Program for the Analysis of Retaining and Flood Walls	Dec 1994
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